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ABSTRACT

The goal of the National Highway Traffic Safety Administration Department of Transportation has been to upgrade and professionalize the ambulance field, enhance its life-sustaining quality, and encourage its establishment where it does not now exist. The course discusses purpose, mission, and duties of the emergency medical technician; leadership; and defines extrication with special attention to the classification of extrication equipment and the extrication system. The section on the accident scene covers events at the scene and phases of the extrication process, including such aspects as reporting and dispatching, emergency medical care, traffic control, disentanglement, and transportation to the ambulance. The major section, description and evaluation of extrication methods, provides a summary of functions for gaining access and disentanglement and emergency medical care procedures, including evaluation at the accident scene, bleeding control, significance of shock, and removal and transport of the victim to the ambulance. Support functions, a tubular summary of functional requirements, and references conclude the course guide. (NH)

ED 098 382

EMERGENCY MEDICAL TECHNICIAN

CRASH VICTIM

EXTRICATION TRAINING COURSE

COURSE GUIDE

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RESCUE & EMERGENCY MEDICAL SERVICES DIVISION

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PREFACE

The goal of the National Highway Traffic Safety Administration (NHTSA) Department of Transportation, pursuant to the Highway Safety Act of 1966 and the Emergency Medical Services Standard 11, has been to upgrade and professionalize the ambulance field, enhance its life-sustaining quality, and encourage its establishment where it does not now exist. With regard to upgrading, it is the view of the Administration that the ambulance attendant or technician does not properly fall into the category of unskilled labor as has tended to be the practice. Rather, this should be a person highly trained and skilled in both lifesaving and life-sustaining techniques. Consequently, the Administration has devoted special effort to plan, develop, and provide the training courses necessary to achieve this end and goal. This Extrication Course is a part of the total planned program of courses. It is the hope of the Administration that it will receive extensive use and further enhance the care of the crash victim.

James E. Wilson
Associate Administrator
Traffic Safety Programs

ACKNOWLEDGEMENTS

The assistance of many individuals and organizations were vital to the development of this course on *EMT Crash Victim Extrication*. We are grateful and wish to thank the U. S. Public Health Service, the Associate Ambulance Service, Phoenix, Arizona; Phoenix Fire Department, Phoenix, Arizona; Emergency Medical Services, Arizona State Department of Health; Emergency Medical Services, Indiana Department of Public Health; Emergency Medical Services Division, Maine State Department of Health and Welfare; and especially the Emergency Medical Services Program staff, Department of Health, Commonwealth of Virginia. Our gratitude also goes out to the Westvaco, Petersburg and Manassas Rescue Squads of Virginia, who pilot tested the course and assisted in the development of the sound slide portion of the training course. We want to especially thank Mr. O. B. Streeper and others who graciously contributed illustrative material to this course.

We are especially grateful and wish to thank Dr. Louis C. Kossuth, Commissioner, Arizona State Department of Health, who served as consultant in the development of this training program, to Mr. Robert E. Motley of the NHTSA, Rescue and Emergency Medical Services Division, who served as technical advisor, and to Mr. Leo R. Schwartz of the NHTSA, Rescue and Emergency Medical Services Division, who contributed to the organization of this material.

Dawson A. Mills

Dawson A. Mills, M. D.
Chief, Rescue and Emergency
Medical Services Division, OSDI
Traffic Safety Programs

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FOREWORD

National guidelines for emergency medical care in the United States were established in the landmark document *Standard No. 11 – Emergency Medical Services*, published by the National Highway Traffic Safety Administration (NHTSA), following the passage of the Highway Safety Act of 1966. The Standard clearly identifies the responsibility of ambulance and rescue services to provide more than transportation alone. It is based primarily on guidelines and recommendations of the National Academy of Sciences (NAS) Committee on Emergency Medical Services in their publication titled "Training of Ambulance Personnel & Others Responsible for Emergency Care of the Sick and Injured at the Scene and During Transport." Consequently, both NAS and NHTSA recommend that all ambulances be equipped with certain lifesaving equipment and manned by at least two persons trained in specified areas of emergency medical care, i.e., NHTSA Basic 81-hour Training Program for Emergency Medical Technician – Ambulance. Specifically, all ambulance services should furnish skilled emergency medical care to victims of all injuries and medical emergencies. Additionally, the *Standard* identifies the need to establish an emergency medical career pattern which provides attractive compensation, prestige, and recognition commensurate with the services provided by these personnel.

Following the publication of Standard No. 11, the National Highway Traffic Safety Administration moved to assist the States in implementation of the national standard in emergency medical services. A first step, to provide the States with guidelines on programs of instruction for ambulance and rescue personnel, resulted in the development of an 81-hour study course, *Basic Training Program for Emergency Medical Technician – Ambulance* and associated *Refresher Course*. The course encompasses the knowledge and skills required to perform all emergency care procedures short of those rendered by physicians or emergency care personnel under the supervision of a physician.

To assist the States further in implementation of the *Standard*, the NHTSA developed two additional courses, *Dispatcher EMT Training Course* and *EMT Crash Victim Extrication Training Course.*

The purpose of this course is to upgrade the skills and knowledge of the emergency medical technician (EMT), in the methods of extricating victims from crashed vehicles. The course also is designed to develop the EMT's ability to establish priorities for removing the victims safely. Although it is designed specifically as an adjunct to the course, *Basic Training Program for Emergency Medical Technician – Ambulance*, this course meets most requirements for teaching light and medium duty extrication methods as an independent course of study. Additional documents produced as part of this course include a detailed *Instructor's Lesson Plan*, and a *Student Guide*, which serves as the course text.

The extrication techniques described herein are those methods considered most appropriate by emergency medical service organizations that assisted in the development of the course. The methods and the equipment identified are endorsed by the U. S. Government but should not be construed as the only possible techniques or tools of extrication.

J. D. Farrington, M. D.
Committee on Injuries
American Academy of Orthopaedic Surgeons
and
Committee on Trauma
American College of Surgeons

SECTION 1

PURPOSE OF COURSE GUIDE

This course guide is the textbook for the Crash Victim Extrication Training Course for Emergency Medical Technician (EMT). Other textbooks may be added by a State or training agency as supplemental information if so desired. The course guide is intended to supplement and to serve as a guide for further training of EMTs who have completed the National Highway Traffic Administration (NHTSA), 81-Hour Basic Training Course for Emergency Medical Technician – Ambulance, or have received equivalent training.

SECTION 2

MISSION & DUTIES OF THE EMERGENCY MEDICAL TECHNICIAN

The emergency medical technician through effective application of his training and skills at the scene of an accident is able to save lives, lessen disability and prevent or alleviate suffering. He is an integral and valuable member of the emergency medical care team. The EMT must be able to combine and apply his emergency medical care skills and extrication techniques to many different situations. At times this might mean proceeding without hesitation to release individuals from life-endangering situations, administering life-support emergency medical care measures to the mutilated and/or recovering and preserving entangled remains of persons involved in violent traffic related accidents.

The mission of the EMT in a traffic related accident, when called upon, is to:

A. Reach, provide immediate life saving measures, and extricate entrapped persons from vehicles and other enclosures without causing additional injuries;
B. Secure the accident scene and create a safe working environment;
C. Provide additional emergency medical care; and
D. Transport injured individuals to the ambulance and on to an appropriate hospital emergency department.

SECTION 3

LEADERSHIP

Experienced leadership is one of the most important factors in extrication. The EMTs must be highly trained in emergency medical care procedures and in the full range of extrication skills and techniques. They must know the availability and capability of local resources, the location of all emergency service personnel and equipment within their jurisdiction, the characteristics of the local geography, and have an established working relationship with and between other governmental departments and agencies that are involved in extrication and accident control. EMTs must command respect, be able to inspire confidence, and elicit a maximum effort from all personnel. They must be able to weigh the entire accident and emergency medical situation and make quick and correct decisions that will save lives, lessen disability and prevent or alleviate suffering. Victim care at the accident scene is the responsibility of the EMT. His responsibility should not be influenced by other service personnel at the accident scene.

SECTION 4

DEFINITION OF EXTRICATION

Figures 1 and 2
Emergency medical care is required prior to and during the extrication process.

Webster's Seventh New Collegiate Dictionary defines *extricate* as: "to free or remove from an entanglement or difficulty. Synonyms: *disentangle, untangle, disencumber, disembarrass* mean to free from what binds or holds back. *Extricate* implies the use of force or ingenuity in freeing from a difficult position or situation; *disentangle* and *untangle* suggest a release from something that impedes or hinders."

All of these activities are suggested as necessary in the vehicular accident situation to obtain the injured and/or trapped victim and place him into the ambulance. Only ambulatory occupants, who can get themselves outside of the vehicle, or ejected victims are exempted from the necessity for extrication. A further extension of the ideas involved is the consideration of emergency medical care requirements to the accident victim. Care is required prior to and during the extrication process (Figures 1 and 2). Preliminary review of such emergency medical care indicates that splinting configurations and supports may make the process of extrication more time consuming and difficult and put considerable emphasis on ingenuity requirements. The intimate relationship between the process and equipment used for caring for the victim and the process and equipment used for freeing him from "a difficult position" suggests the following: "All personnel, activities and

equipment related to and used within the near vicinity of the accident scene from the time of detection of the accident to the time of placing the victim into the ambulance are a part of the *automotive accident rescue extrication system."* This definition puts an emphasis on time because it is often important to begin rescue procedures quickly, and because other necessary traffic control and fire prevention activities may detract from the time actually spent in extrication and direct emergency medical care. Activities in the near vicinity may include such diverse actions as reporting the nature and extent of the accident and giving instruction to ambulance and rescue personnel as to the quantity and type of equipment to provide. While time may be precisely measured and described, the definition of "near vicinity" will vary an indefinite amount depending on highway and street conditions, traffic density, location of involved vehicles following the accident, weather, time and many other situations.

A. CLASSIFICATION OF EXTRICATION EQUIPMENT

In the broad sense, all equipment used during this time period is at least, "extrication related equipment." The extrication equipment may be classified as follows:

Group I. Access and Disentanglement Equipment:
Hardware used to mechanically deform or displace the vehicles, building, vegetation, or other physical impediments involved in a vehicular accident in order to gain access and to free a trapped victim from a state of entanglement or enclosure which prevents ready removal. Examples: pry and wrecking bars, boltcutter, air cutting gun, porta-power equipment, jacks, etc.

Group II. Equipment for Preparation, Removal and Transportation to Ambulance:
Hardware used to prepare the victim(s) for removal and to actually remove the victim from the enclosure or vicinity of an accident to the ambulance. This may include emergency medical care devices such as splints, backboards, stokes litter, and orthopaedic type stretchers.

Group III. Medical and Emergency Medical Care Equipment:
This group includes those devices related to the physiological well being of the victim which are not specifically required for body support or fixation. Examples: airways, bandages, dressings, I.V. fluids etc.

Group IV. Extrication Support Equipment:
Devices used to control the environment in the vicinity of the extrication process, to assure provisions of appropriate equipment at the scene of the accident and otherwise expedite extrication, extrication and emergency medical care of the victim during the extrication process. Examples: Lighting equipment, fire prevention, communication systems, wreckers and tow trucks, etc.

The emphasis in this extrication course will be on the first two of the above categories of equipment and related procedures. However, considerations of the emergency medical care activity and equipment as

well as the extrication support equipment and procedures will be included in less detail.

B. EXTRICATION SYSTEM

The hierachy of system component parts in the extrication system are illustrated in Figure 3. The structure or organization of the extrication system is useful for explaining many relationships. It should be noted that the entire process consists of a number of essential functions performed in series. Although not all of these functions need be employed in any one crash situation, the possibility of need for any one of them might arise. So viewed, groups of these activities could be recognized as functionally related in what is later called *phases.*

SECTION 5

THE ACCIDENT SCENE: POST CRASH EVENTS AND AGENCY INTERACTION

From an analysis of the available literature, it has been observed that very little has been written on this subject of extrication systems. The only two documents, of any substance, that provide the community planners with detailed guidelines in developing plans to coordinate activities at the accident scene are the NHTSA, Highway Safety Program Manuals, Volume 16 – Debris Hazard Control and Cleanup and Volume 11, Emergency Medical Services. It appears useful, at this point, to provide a kind of synopsis, or system-oriented description, of some of the activities which take place during this time in order to point out and describe the large number of personnel and agencies which may be associated with the extrication activity.

Figure 4
Roadside telephones should be toll-free when used for reporting emergencies.

A. EVENTS AT THE SCENE OF A VEHICLE CRASH

It is not possible to characterize a typical accident scene by a simple, straight-forward synopsis of events and procedures performed by various personnel. It is a matter of chance as to who is available and willing to report the accident to the proper authorities. Probably most vehicle accidents are discovered and reported by persons passing by who are not involved in the accident themselves. However, there may be persons within the involved cars who are able to egress from the car and to make their way to a telephone or other means of summoning help (Figure 4). Law enforcement officers in a patrol car, a rural mail carrier, a school bus driver, or county health official, may be first at the scene of the accident. Depending upon personal background, training,

THE ACCIDENT SCENE: POST CRASH EVENTS AND AGENCY INTERACTIONS

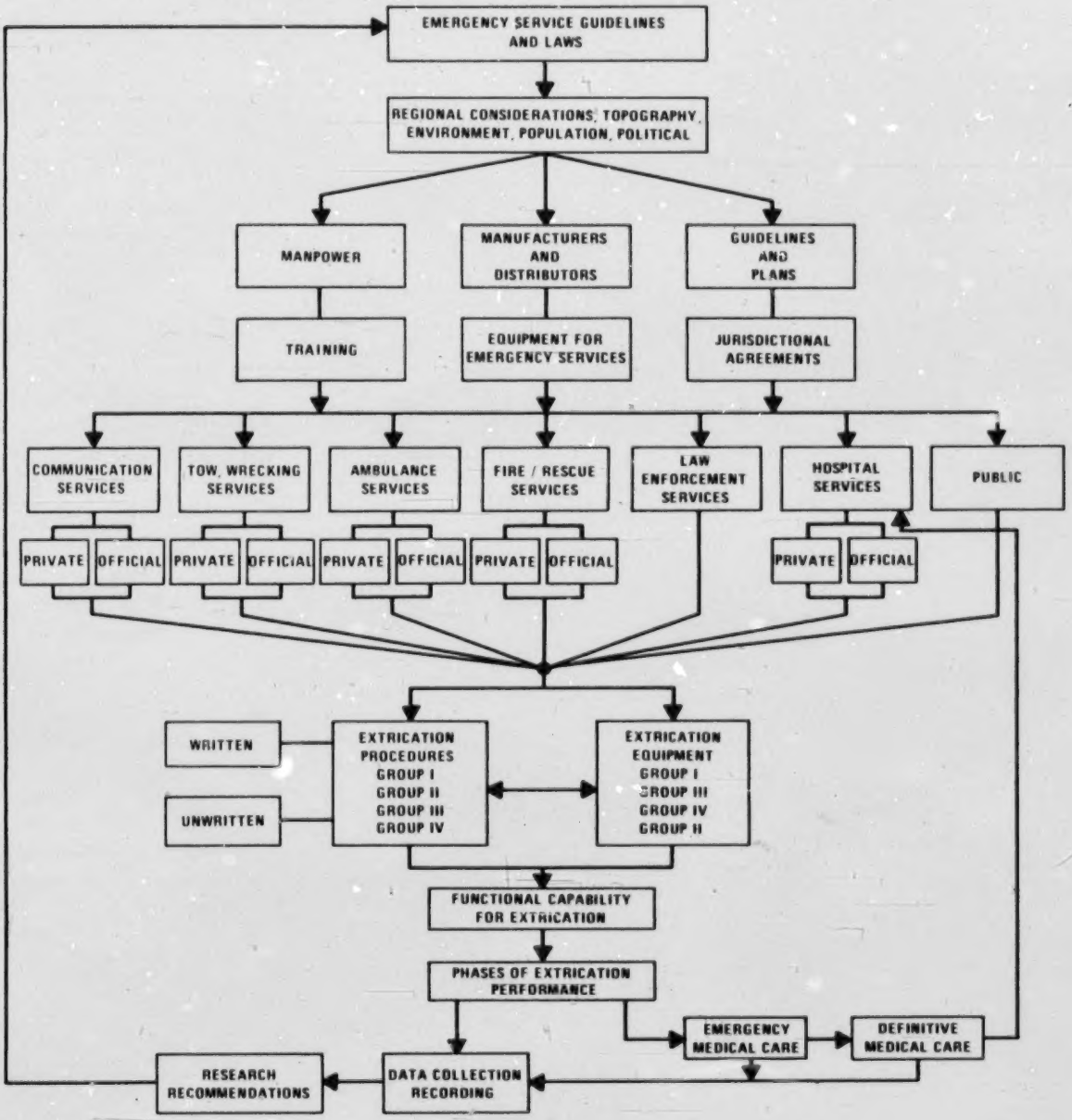

Figure 3 Extrication System

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responsibilities and financial interest, reports on the condition of the accident victims, topography, and descriptions of the vehicles at the scene of the accident will be made. In some areas, a passerby may have to travel several miles to get to a telephone, in city areas it may be just a short distance to a telephone or call box installation at the side of a freeway, or to the nearest service station by an off-ramp. A decal providing the location and a listing of emergency numbers could be affixed to each roadside telephone to aid the motorist in reporting his location. Many ambulance and rescue services furnish decals with appropriate emergency numbers listed and distribute them to all telephone subscribers. In some areas, telephone operators are trained to respond to a person who wishes to report an accident by immediate notification of the police. They may call the police directly, or connect the caller to a police station which will take the report. Because of long distances in rural situations, it is very possible that the passerby may elect to stop at the accident and attempt to render assistance before going for help on the theory that immediate help, although amateur, is more important than professional emergency medical care that may be obtained considerably later (Figure 5). In these remote and rural areas the community ambulance and rescue services could provide a valuable community service by offering classes in advanced first aid or a course of instruction designed specifically to meet vehicle accident emergencies. Such training programs will assure that proper immediate life-saving measures are carried out properly by the passerby.

Figure 5
Training programs must be made available to the general public – a responsibility of local ambulance & rescue services.

When law enforcement agencies are notified, they generally dispatch a nearby patrol car to the scene of the accident, and they may call an ambulance and fire department according to the information they receive. Because the accident is generally reported by untrained personnel, it is often difficult to get accurate information as to what is really required at the scene of the accident, especially in the way of extrication services. The NHTSA – Dispatcher Emergency Medical Technician Training Course, will be of benefit to community emergency medical services planners, in developing proper training programs for the local dispatchers. Ambulance and fire department vehicles should be equipped with two-way radios, which can be used to request assistance from police and/or other rescue agencies at the time of accident discovery. In a large city, with specialized vehicles in the fire department, several vehicles may roll to the scene of the accident, on the chance that they may be necessary.

Figure 6
Hazard control is essential at the accident scene.

Typically, an engine company (pumper truck) and/or a tank truck is sent to wash down gasoline, as a minimum requirement (Figure 6). A truck company, or hook-and-ladder is often sent to provide for access and extrication services. A heavy utility truck may be dispatched at the same time, it may be called later after further investigation reveals that available equipment on the other vehicles is insufficient to handle the problem. If the victims are all extricated by the first company arriving at the crash site, the others will be told by radio to return to their stations so that they do not actually arrive at the scene of the accident.

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THE ACCIDENT SCENE: POST CRASH EVENTS AND AGENCY INTERACTIONS

Figures 7 and 8
Prompt removal of wrecked vehicles to avoid further impacts.

Law enforcement agencies are usually considered to have primary responsibility for conduct of activities, not however patient care, at the scene of an accident (Figures 7 and 8). However, their primary concern is control of traffic, although many of the officers are taking advantage of special emergency medical care courses and will perform immediate life saving emergency care procedures until the arrival of an ambulance crew or fire department crew. Law officers will set out flares or other warning signals and park their cars with flashing lights to indicate the possible danger to oncoming traffic. If necessary, they will attempt to divert traffic to avoid impacts and to clear the roadways as soon as possible. All other emergency vehicles should park their vehicles off the roadway in a position that will afford the maximum amount of illumination of the accident scene.

Tow trucks will usually appear on the scene very quickly on city freeways as many of these towing services monitor police calls and other fire department calls to determine the location of accidents.

The ambulance and/or rescue service may be called at the same time as the fire department or other vehicles, or it may be called later, depending upon the area being served and the practices of the agencies involved. Private ambulances may respond to the emergency calls or the ambulances may be attached to a municipal or county fire department or a volunteer ambulance or rescue squad.

When the fire department, or other rescue unit, arrives it will assess the situation and set up hazard control efforts such as washing down gasoline, control of smoke and fire, stabilization of possible debris or other threatening objects which may fall, and provide extrication services, if necessary. A fire department may have attached to its emergency services a physician from a local hospital who will also arrive at the scene, either because of a call to the hospital or because he has monitored it on his own car radio. Occasionally, a physician will be passing by, and stop to render assistance.

In case of a spectacular accident involving a great many vehicles or rather unusual damage, the news media may be notified by the police or the fire departments, and vehicles from the newspapers and television stations may appear at the scene. Of course, whenever there is a large number of vehicles passing by, there is a general slowing of traffic on both sides of the highway as persons slow down, either as a caution or as a matter of curiosity. A fire department or rescue service may obtain a photographic record, usually made by a photographic unit which comes to the scene. The followup of such accidents by the news media by interviews of the ambulance and rescue service personnel at the scene can serve as a public information mechanism. The community will support the emergency medical services if they are made aware of some of the deficiencies of the services, if any.

When multiple victims are involved, several ambulances may be required to take care of all the injured victims. There will be attempts by the police/law enforcement officers to obtain information for their reports, such as the vehicle license numbers, the makes, the models, the names

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of the drivers and occupants. These reports are generally designed to provide information which related to the causes of accidents in order to establish driver responsibility, negligence, or criminal intent. There will be an exchange of names and addresses between drivers, whenever possible, so that their insurance companies can be notified. The ambulance and rescue personnel should be certain that this information gathering does not delay the immediate care and transportation of the seriously injured.

Figure 9
Essential that each service at the accident scene have defined responsibility.

Thus, the accident scene involves personnel from a great many different agencies for specific functions which need to be performed, and there are considerable arrivals and departures. These functions may be nominally allocated to different agencies, according to the particular political and physical character of the region, but the persons at the scene of an accident frequently decide who will do what according to their individual background and previous training, the leadership exerted, and the situation (Figure 9).

Ambulance and rescue personnel have an obligation to encourage their emergency medical services community planners to develop an emergency service plan that identifies total resources, potential hazard areas, agencies that have a responsibility to respond to accident situations, and to identify individual agency responsibility at the accident scene.

Previous systems analyses of the pattern of events in vehicle accident emergency care systems has not treated the activities of extrication in detail. Therefore, it appears profitable to reexamine the emergency care system from the viewpoint of its relation to extrication activity. For this purpose, analysis of the events related to the crash scene has suggested that there are nine *phases* of activity which potentially are performed in various sequences during the extrication process. These are defined and described in the following paragraphs.

B. PHASES OF THE EXTRICATION PROCESS

The nine phases here considered to comprise the extrication situation arise as follows:

1. Reporting and Dispatching
2. Rendering Emergency Medical Care
3. Transportation of Rescuers and Equipment to Scene of Crash
4. Traffic Control
5. Controlling Non-traffic Hazards
6. Gaining Access
7. Disentanglement
8. Preparation for Removal
9. Transportation to the Ambulance

The discovery of the accident prior to the above phases and transportation to a medical facility subsequent to placement of the victim(s) in the ambulance are important phases of emergency medical care, but are not considered phases of the extrication situation. The

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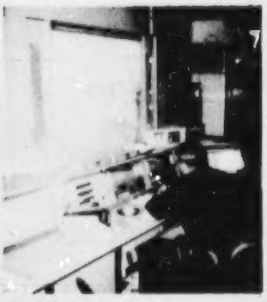

Figures 10 and 11
Central Dispatch – an essential element in the emergency medical services system.

Figure 12
A quick visual check of the victims by the EMT is essential for victim survival.

general content and pertinent factors of each of the nine phases is discussed and explained in some specific detail in the following paragraphs.

1. Reporting and Dispatching

Reporting and dispatching activities are essential to summon the rescue crew, police, ambulance, tow trucks, fire departments, physician, utility companies, etc., who may perform or assist in the extrication process. Potentially, communication by voice and telemetry could further improve medical care by enabling physicians to advise upon medical data transmitted to hospital emergency departments (Figures 10 and 11). Although the necessity of such communication facilities is recognized herein, this course will not be deeply concerned with the electronic design, range, frequency or organization of communications systems. Such systems are described adequately in NHTSA, publication: *Communications – Guidelines for Emergency Medical Services.* The main concern in this course will center on information which should be transmitted.

2. Rendering Emergency Medical Care

The scope of this term is primarily emergency medical technician assistance. However, other medical care rendered by a physician who may be at the scene of the accident is also considered as part of this phase and psychological comforting is included. The simplest form of emergency care might be a swift visual check and questions to ascertain absence or presence of injuries (Figure 12). Emergency medical care might be initiated immediately upon discovery of the crash by the first person on the scene. Such immediate medical care should be directed toward insuring that a clear airway exists and that it is maintained, by artificial respiration if necessary. Bleeding should then be controlled. Progressive emergency medical care should protect all wounds, insure that all fractures are splinted, and protect against the effects of shock.

Emergency medical care procedures do not contribute directly to the process of extrication in terms of physically removing or untangling the wreckage, or debris from the injured, but they are essential to the proper accomplishment of extrication procedures and to their primary goal – the saving of human lives. The degree and effectiveness of assistance rendered is dependent upon gaining access to a victim, the training of the personnel, the equipment available, and the condition of the victim. Limited access to the victim may prevent the most effective care and treatment, but all attempts must be made to insure that life can be maintained. As access is improved, or as well-trained personnel with adequate equipment arrive at the scene, better care may be provided. Not only must the life-threatening medical problems be resolved but those which cause unnecessary permanent injury or needless suffering should be treated as soon as possible.

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Problems bearing on extrication which have been cited by physicians discussing the subject include the following:

A. Failure to institute life-saving techniques such as:
   a. Establishing an airway
   b. Maintaining an airway and artificial respiration
   c. Control of bleeding
   d. Closed chest heart compression
B. Poorly trained personnel responding to emergency calls
C. Long delays in responding to emergency calls
D. Long delays in detecting the accident
E. Insufficient or inadequate design of equipment
F. Movement of victim(s) by untrained personnel

3. Transportation of Rescuers and Equipment to Scene of Crash

The dispatching and transportation of apparatus which is appropriately equipped to effect rescue are vital to the success of extrication procedures. Although these activities take place peripherally, prior to the major extrication effort, they are indeed a part of the extrication system. Travel time and routing may influence the success or failure of life saving activities. However, in this course emphasis has been directed toward events at the crash scene and this phase is considered as relatively incidental.

Figures 13 and 14
Some extrication tools may generate a fire hazard – vehicles and victims burn.

4. Traffic Control

Necessity for control of traffic is apparent to prevent further accidents and injuries and to help assure a safe working environment for rescue equipment and personnel. It is also a factor contributing to delays in extrication, in that a law enforcement officer may need to select which of two functions he must perform: rescue or traffic control. Again, this phase is noted as significant, but generally is not to be treated in depth in this training course.

5. Controlling Non-traffic Hazards

Imminent, or actual, fire hazards and other less frequent hazards, may need attention before or during the extrication process. The depth of involvement of rescue personnel with this phase will depend on the situation, number of personnel responding and available equipment. By traditional assignment of duties, fire department personnel active in extrication processes are also responsible for fire control and are usually the only agency equipped with smoke or gas protection masks. In areas where fire apparatus does not respond with the ambulance it is recommended that the ambulance be equipped with quick entry masks. Some extrication equipment, particularly access equipment, may generate a hazard of fire due to sparks, heat or explosion and protective gear must be included for such cases (Figures 13 and 14). Identification and availability of all necessary hazard control and rescue equipment with agency names, individuals in charge, and emergency telephone

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Figures 15 and 16
Gaining access may appear to be more of a problem than it is – survey the entire scene to determine the quickest access route.

numbers, must be identified in the community and the information made available to emergency medical services and dispatching personnel.

6. Gaining Access

Gaining access to the near vicinity of a crash victim may be a major problem. Access to a victim depends on the post-crash location of the vehicle, its position or orientation, damage to the vehicle, and the position of the victim in relation to the vehicle. Access is necessary for emergency medical care to be administered. Gaining access may be accomplished as easily as opening a door on a vehicle (Figures 15 and 16). However, it may be as difficult as descending the side of a cliff and then cutting open a severely crushed vehicle which entraps a victim who is barely alive (Figure 17). In such cases, the transportation of rescuers and equipment to the crash scene may almost be considered as part of the gaining of access.

Gaining access may be dangerous to all rescue personnel and consume a great deal of time and resources. Hazard control activities are needed to mitigate the dangers and traffic control problems may be affected. The victim may or may not be injured, and the means of gaining access must take this into account. Access to a victim might involve prying open the doors of a vehicle, cutting off the roof, jacking up a portion of the vehicle, sawing through a tree, removing debris, breaking through glass, or any other means of physically reaching a victim.

Crash energy directly affects access. Severe weather conditions and local terrain may also hamper efforts.

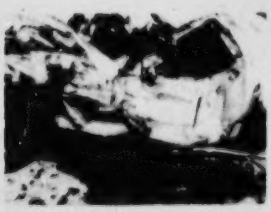

Figure 17
Gaining access to the victim in other cases may create serious problems to the EMT.

7. Disentanglement

Disentanglement of the victim from his immediate, intimate surroundings is accomplished after access has been gained. Emergency medical care may be rendered prior to, during, and after disentanglement. Although primary concern is naturally directed to subsequent removal of the victim from the vehicle, the concept of removing or *disentangling the vehicle from the victim* should be more properly emphasized to prevent further injury. It should be realized that each accident may present its own peculiar set of circumstances, ranging from specific to general entanglement patterns.

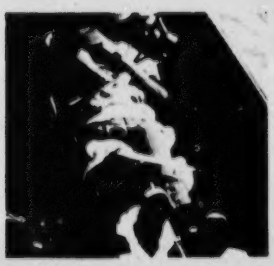

Figure 18
Careful movement of the accident victim as a unit is necessary to prevent further injury.

Tools and equipment may be required to free a victim from his entrapment or involvement with the vehicle. However, this is not always the case. The victim in the vehicle might be trapped by a seat which can be manually removed. In some cases, careful movement of the body as a unit, preferably after preparation for removal using splints, backboards and other supports, will free him (Figure 18). In other instances vehicular deformations are such that only the physical removal or forcible displacement of portions of the vehicle will permit him to be freed.

Tools required for disentanglement might include a come-a-long and chain to pull a steering column away from the chest of a victim or a

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hydraulic rescue unit which spreads the instrument panel away from the trapped legs of a victim. Many times, gaining access to the victim is accomplished in such a manner that disentanglement occurs simultaneously. Bulky or cumbersome tools, inadequate tools, lack of training, and environmental factors such as rain, cold, snow, and difficult terrain are negative factors resulting in delays and increased suffering.

8. Preparation for Removal

Once the structure and other impediments have been disentangled from the victim and other physical restraints in or around the vehicle have been removed, the victim should be carefully prepared for initial movement or removal from the vehicle and subsequent transportation to the ambulance. This preparatory activity is intimately related to, and directed toward: (1) protection of the victim from further injury during transport, and (2) facilitating removal. The latter intent may cause some observers to consider this phase as actually a part of the subsequent "initial movement" or "removal" phase. This is consistent with descriptions of other phases in which the unstowing, preparation, and set up of tools, lights, donning of gloves, etc., are not separately discussed. However, some authorities indicate that currently there is too little emphasis on and training for proper immobilization and traction of crash victims *prior* to removal. Therefore, the rather arbitrary distinction of separate phase of activity has been assigned here for classification.

Figures 19 - 21
Essential steps in victim care – quick entry – airway maintenance – bleeding and shock control.

Part of this preparatory activity may be initiation, or assurance, of continuing emergency medical care for all life-threatening injuries such as airway and breathing maintenance, control of bleeding and protection against shock (Figures 19 through 21). Wounds should be dressed as well as possible in the situation with consideration given to the dangers of possibly hindering medical access due to application of splints and backboards.

9. Transportation to the Ambulance

This phase may consist of merely wheeling the victim to the transportation vehicle in a litter or it may be as complicated as winching a covered basket or backboard up the side of a brush covered hillside. It includes all those activities which take place between the initial movement or removal of the victim from the confines of the vehicle to the point of placing him into the ambulance.

However, once a victim is placed on a wheeled litter (gurney) on a relatively level area near an ambulance, he has for all practical purposes, been removed from the extrication subsystem.

The foregoing phases are concerned with activities *at the scene of the accident*. For completeness of system analysis one should also be concerned with the *administrative* and *preparatory* activities which provide the trained personnel and equipment in readiness for such extrication processes. Some of these considerations will be included in further discussions in this course.

SECTION 6

DESCRIPTION AND EVALUATION OF EXTRICATION METHODS

In this section, examples of extrication methods are described and evaluated, and general principles and functional requirements for extrication are derived from this analysis. The organization of this section is based upon the relative significance and uniqueness of the various phases previously identified in relation to the major intent of the training course. The discussion of methods is centered around the four groups of extrication equipment and related *phases* set forth in the definition of extrication:

Group I Gaining Access and Disentanglement
Group II Preparation for Removal, and Transportation to the Ambulance
Group III Continued Emergency Medical Care
Group IV Support Operations

Each of these groups is considered in turn in the paragraphs that follow.

A. GROUP I – METHODS AND PROCEDURES FOR GAINING ACCESS AND DISENTANGLEMENT

Methods of gaining access and disentangling vehicle parts and debris from around the victim require alternate approaches and exercise of ingenuity in the use of available methods and tools. The primary problem is that no two accidents are exactly alike, although some similarities may exist. Preparatory to gaining access to the victims, one should survey the entire accident scene and determine if special hazards are present, and if the required tools and emergency services are on hand. Some of these hazards may be controlled by methods which will be discussed later. Hazard control efforts should be initiated if there is a threat to life during the process of extrication. Such control efforts would include: traffic control, stabilization of wrecked vehicles, washing down gasoline or other hazardous materials, cutting off power to downed wires, etc. Trade-offs must be made at the scene as to the available time, the preferable methods, and the inherent dangers in each method with consideration for victims, rescuers and bystanders.

Great care must be exercised during the disentanglement process. It is at this time that the tools and equipment are in the closest proximity to the victim, and their effect upon him must be carefully considered. Physical manifestations of energy in all of its forms must be taken into account when the tools are used. The effects of excessive heat, pressure and force on the victim must be minimal, and evident and possible injuries must be taken into account. The possibility of a fractured spine must be a prime consideration when the victim is moved to free him from the wreckage. As disentanglement proceeds, efforts to render emergency medical care should continue as additional body areas become accessible for treatment. In the case of pinned victims the emergency medical technician should be alert to severe bleeding potential temporarily controlled by the pressure of a structure of the automobile, such as the steering wheel. When this structural pressure is released, additional bleeding can occur which must be immediately controlled. Disentanglement, as well as access to the victim, depends, to

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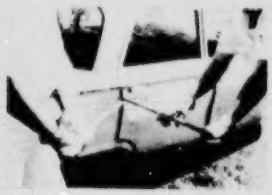

Figure 22
Pry and wrecking bars to provide space to insert wedge.

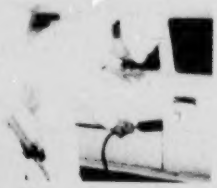

Figure 23
Application of hydraulic wedge.

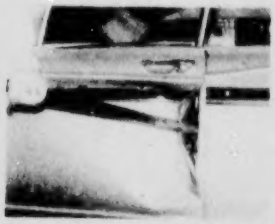

Figure 24
Door sprung opened.

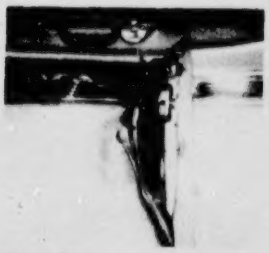

Figure 25
Pry and wrecking bars to pry open door exposing safety locking mechanism.

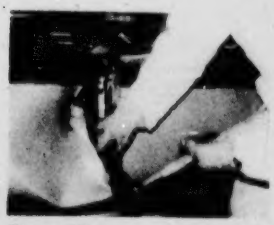

Figure 26
Hammer and chisel cutting through *rivets* which hold locking bolt.

a great extent, upon the skill, training, and imagination of the emergency medical technician. If the EMT is well trained and experienced, he will cause fewer additional injuries. Many deformations resulting from high speed crashes require a variety of operations be performed to free a victim. Knowledge of mechanics and the action of all of the tools and equipment and their capabilities will aid in efficient disentanglement.

Vehicle construction and deformation are of primary importance and directly affect, first, the manner in which a victim is pinned or trapped, and second, the means of disentanglement. Factors such as vehicle orientation, access routes, injuries, and environmental conditions, natural as well as crash induced, will also have an influence on procedures followed during this phase.

Generally speaking, most emergency medical technicians feel that the best procedure is to use devices which do not create sparks, heat, or flame because of the danger of spilled fuel in the vicinity of the accident. There will of course be times when power saws, drills and torches will be required. With proper fire control measures the danger of fire will be lessened. Creative thinking on the part of the emergency medical technician, determines, in fact, the success or failure of the extrication.

Typical procedures for cases involving locked or jammed doors will involve prying and cutting tools of various kinds to spread metal, open up doors, or provide an opening through the vehicle in some manner. The most powerful and versatile tool is probably the hydraulic rescue unit with the wedge extenders and spreader attachment tools; however their use requires an opening to begin with. A pry bar or crow bar is often used to force into the edge, between the door and the car frame, to widen it sufficiently to make room to insert the jaws of the spreader. Then the wedge may be utilized so that when the hydraulic device spreads the opening, the wedge can be slipped in as the opening gets wider. The process should be repeated until the door is sprung opened. In case of any slippage or breakage of the spreader the wedge holds the door from springing back. A set of photographs illustrating this procedure is shown in Figures 22 through 24.

The above procedure may not be effective for gaining entry into automobiles manufactured after 1966, due to the safety door latches. If the door is crushed and locked or stuck in these later model cars it is near impossible to force them opened using the above mentioned procedure. A hammer and chisel or the pneumatic or air cutting gun with the flat cutting chisel attachment may be used to cut through the rivets in the locking device after the bolt in the locking mechanism has been exposed with the prying and expanding tools as previously described. A set of photographs illustrating this procedure is shown in Figures 25 through 27.

A third procedure would be to cut a section out from around the door handle with the air gun using the sheet metal cutting chisel. After cutting a "U" shape section around the door handle the section can be

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Figure 27
Door opened. Detachment of entire locking mechanism from vehicle door post.

Figure 28
Air gun using twin blade panel cutter to cut "U" shaped section around door handle.

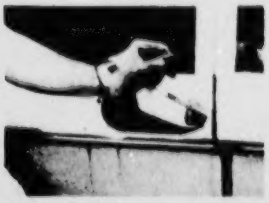


Figure 29
With gloved hand use door handle to bend the section back to expose locking mechanism.

folded back exposing the entire locking mechanism. By pulling up on the lock release bar with a *gloved* hand or screw driver the door can usually be opened. A set of photographs illustrating this procedure is shown in Figures 28 through 30.

A fourth procedure would be to use a sharpened auto leaf spring and a heavy hammer in place of the air cutting gun to expose the locking mechanism. A set of photographs illustrating this procedure is shown in Figures 31 through 33.

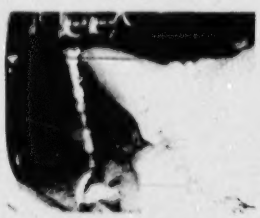
In cases where the distance between the parts to be moved is considerable, the porto-power expansion tool arrangement may be used. Various fittings are available to engage the structure and to prevent slippage as force is applied (Figures 34 through 36). When there is an insufficient extension capability, blocks of wood are used in many cases to take up the distance. This is called cribbing. Blocks of wood are also used to spread the load into the sheet metal structure or over sandy, or soft soil. Typical cases are where the knee, or lower leg, is jammed between the dash panel and the floor board, or where persons are trapped underneath the dash or under a collapsed roof. The extender unit is put in and force applied. In a reported accident three boys were squeezed together between the dash board and floor of a car which had rolled a considerable distance after failing to negotiate a turn. They were held so tightly they could barely breathe. Fumes from fuel permeated the air, and fuel had spilled onto the sandy soil surrounding the vehicle creating wicking action to feed any flame which might start. Although one of the possibilities was using a cutting torch to begin to take the car apart, it was decided that the best approach was to use the hydraulic rescue kit to spread the floor and dash panel away from each other. Oxygen was supplied to the boys under the dash panel in order to make their breathing more efficient, although it was recognized that this was an inherently dangerous action, if oil had been spilled in the area, because of the flammability situation.

Figure 30
Lift up lock release bar to open door.

Figure 31
Hammer and sharpened auto leaf spring – an inexpensive yet effective access tool.

Figure 32
Cut "U" shaped section from around door handle.

Figure 33
Lift up lock release bar to open door.



Figures 34 and 35
Porto-power with extension tube to raise dash board to release victim's leg from entrapment.

Figure 36
Porto-power with additional extension tubes to raise the roof of a crushed car.

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Figure 37
Wedge ram used to lift front seat to release foot of trapped victim.

Figures 38 and 39
Gaining access, in some cases, means merely opening a door opposite from the side where a major deformation has taken place.

Figure 40
Victim trapped under car. Build cribbing blocks under frame of car.

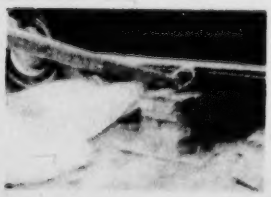

Figure 41
The longer the pole the easier it will be to raise the car.

Another example of a spreading activity using the expansion wedge is shown in Figure 37, in which a small girl's foot was trapped between the floor and the bottom of the front seat of the car. The hydraulic wedge was used to lift the front seat sufficiently to release her foot. If more lifting was required a small block of wood could have been placed under the wedge or the spreader.

The above examples of lifting the seat of the car and the example of the trapped boys illustrate the concept of *disentanglement*. The effort in these cases was to *move the machinery away from the victims*, not to move the victims from the machinery. The first examples (various methods of opening doors) were cases of gaining access. There were no disentanglement problems in these particular cases. There are other cases in which it is clear that the process of *gaining access* and of disentanglement are identical, as regards the use of tools. The gaining of access, in some cases, means merely opening a door opposite from the side where a major deformation has taken place in order to get inside and to effect a rescue (Figures 38 and 39).

Disentanglement may be a very simple matter, also, and sometimes movement of the subject with respect to the vehicle is the best way. One example of this is a case in which a victim's foot had jammed into the floor board. When the EMT arrived, he found that the foot was moveable within the shoe, apparently unharmed. By cutting the shoe laces, the EMT freed the victim, who was readily able to move his foot from the entrapment, leaving the shoe caught in the machinery. This is an example of a case where only a very small, sharp knife was required to meet the situation. It is also an example of a case where psychological considerations helped the victim's state of mind. The victim, who was already very frightened, may have become hysterical when the EMT pulled out his knife, fearing that he was going to cut his foot off, rather than release it from the shoe. A small amount of explanation at this point saved the victim considerable disturbance.

Another major category of rescue involves lifted and pulling. Lifting is a special case of pulling or pushing, in which movement is vertical. Lifting may be accomplished by a pry bar, hydraulic or mechanical jack, or a winch and chain or cable. It is done in order to effect rescue of a person trapped under a car, as an example. In this case, combining the use of a hydraulic jack and cribbing blocks, it is essential that the base of the jack is on a firm surface to prevent it from being driven down into the soft ground. Cribbing blocks, or a metal plate will usually provide a sound base. As the car is lifted from the victim, cribbing blocks should be built up to support the car, to prevent it from dropping back onto the victim, in case the jack slips. If more space is required after the jack has been extended to its limit, it should be lowered and removed. The car will then rest on the cribbing blocks until the jack can be built up to the required height by placing it on cribbing blocks. This procedure is illustrated by photographs in Figures 40 through 42. Rope slings could have been affixed to the top portion of each of the cribbing blocks. The rope slings make it much easier for the EMT to scoop up a number of blocks at one time in each arm (Figure 43).

The concept of displacement by pulling is frequently employed in rescue operations. Two situations appear to reoccur quite often, first,

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Figure 42
A safety measure, build cribbing blocks up as car is lifted in case pole slips. Pull victim out in a straight line to avoid further injury.

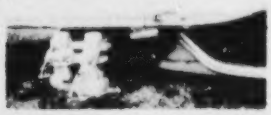

Figure 43
Rope slings on each block facilitate gathering blocks before and after extrication.

Figure 44
Remove metal stripping with baling hook and rubber gasket with a lineman's knife.

to move a front seat rearward and second, to pull a steering column forward in disentanglement procedures.

The first case – pulling the steering column forward. The victim is pinned by the steering wheel. After one EMT has gained access to the victim and stabilized him as much as possible, the other EMT begins the disentanglement operation. It will be necessary to remove the front windshield. Using a baling hook or a similar clawing device, remove the metal stripping from around the windshield. A lineman's knife is then used to remove the rubber gasket from around the windshield. In some cases, especially in older models of cars, the rubber gasket may have dried and set making it most difficult to cut away from the windshield. To assist in carrying out this operation the EMT inside the car may use his feet rather than his head, by sitting back on the front seat and pushing against the windshield with his feet. After the windshield and the metal stripping have been removed they should be discarded away from the working area. The chain or cable to the come-a-long should be secured to a sturdy structure on the underside of the automobile. Shoring blocks placed under the chain at appropriate locations prevent the chain from sinking into the soft sheet metal and causing a snag. To release some of the pressure from the victim caused by the steering wheel, and to allow sufficient clearance when the steering column is pulled forward it may be necessary to cut off all or a portion of the steering wheel. Inform the victim what procedure you are about to carry out. Protect his face from flying chips when cutting the plastic material from the steering wheel. If your bolt cutter is not of sufficient size to bite into the steering wheel a channel pliers may be used to strip away a section of the steering wheel. A set of photographs illustrating this procedure is shown in Figures 44 through 51.

Figure 45
Pry up windshield from bottom and lift up for easy removal.

Figure 47
Remove windshield, stripping and other debris away from work area.

Figure 49
Shoring blocks should be placed at locations receiving the greatest amount of force when come-a-long is put into motion.

Figure 51
Steering column and wheel pulled away from victim.

Figure 46
In older cars rubber gasket may have set. May be removed by forcing it out with feet of EMT in front seat of vehicle.

Figure 48
To set up come-a-long to pull steering column, secure a chain to a sturdy structure on the underside of the vehicle.

Figure 50
Why shoring block must be used.

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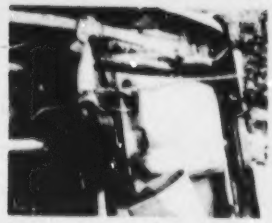

Figure 52
When pulling front seat secure chain around a sturdy structure on underside of the vehicle.

Figure 53
The chain should be wrapped around the solid part of the front seat, not around the seat tracks that are secured to the floor of the car.

Figure 54
Placement of come-a-long and cribbing blocks.

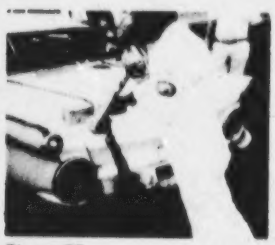

Figure 55
Apply steady strokes on come-a-long to avoid a sudden release of front seat which may cause additional injury to the victim.

The second case – pulling the front seat backwards. If after carrying out the above procedure, pulling the steering column forward, there is not sufficient working space to remove the victim from the car safely, the seat may be pulled backward. If the seat cannot be released and slid back manually, the same procedure as described above should be followed. In addition, the rear window should be removed and the come-a-long positioned with the chain through the opened rear window. In this instance the chain should be wrapped around the solid part of the front seat, not around the seat tracks that are secured to the floor of the car. The chain should be centered creating an equal pulling strength on both sides of the seat at the same time. With very little effort, using the come-a-long and one EMT holding back the seat release handle the few remaining teeth on the sliding mechanism will be stripped and the seat pulled off of the mechanism. A set of photographs illustrating this procedure is shown in Figures 52 through 56.

In the case of automobile accidents where the car is on its side, access may be gained by removing the roof or cutting a hole in the roof. The car of course should be stabilized with cribbing blocks before any cutting takes place. An EMT should gain access to the victim(s) as soon as possible to provide immediate life saving emergency medical care and to stabilize the victim(s) until they can be better prepared for removal.

In many cases the most expeditious method of gaining access and to provide an exit for the safe removal of the victim(s) is to cut a "U" shaped section of the roof and fold it down. The air (pneumatic) cutting gun with the sheet metal cutting chisel probably will be the fastest and safest tool for this procedure. By cutting the "U" shaped section of the roof it can be pealed down and flattened to the ground. The section *should not* be entirely cut out as this would produce a sharp edge which could cause injury to the EMT and the victim(s). The roof rods on some models snap out with little effort on most models of cars, for those that do not they may be cut out with the bolt cutters. The metal support may be cut out with the air gun using the flat cutting chisel on the spot weld splitter accessory. The upholstery ceiling cover can then be torn away, but be careful the victims do not spill out during any of the above procedures. When cutting the access hole in the roof make it large enough the first time to allow for easy removal of the victim who in most cases will have to be placed on the long backboard or an orthopaedic type stretcher (Figures 57 through 60).

At the scene of all accidents it is imperative that a thorough search be made by the EMTs for all victims. The following newspaper accounts clearly illustrate this point:

1) An injured teenage driver of an overturned vehicle regained consciousness after 72 hours and inquired as to the whereabouts of his three friends. Rescuers had found one teenage girl that arrived at the hospital DOA. The boy explained that two friends had hidden in the trunk of the car to avoid paying admission at the drive-in movie they had intended to see. Police officials checked the vehicle at the city impounding lot and found the two missing boys in the trunk – dead.

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Figure 56
When possible move front seat back as far as possible. Only the last few teeth on the runner need be stripped to release the seat.

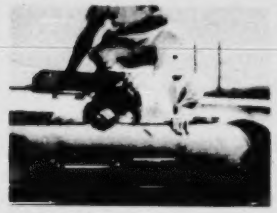

Figure 57
Quick entry to begin life saving measures.

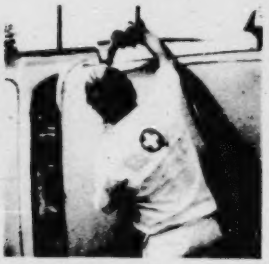

Figure 58
Using air gun and twin blade panel cutter cut a large "U" section in the roof to allow for sufficient room to prepare victims for extrication.

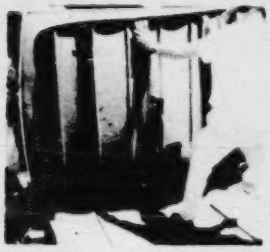

Figure 59
Roof rods in some models can be pulled free or they may be cut with bolt cutters. The metal supports cut with air gun using spot weld splitter attachment.

2) A ton and a half closed van truck missed a turn and ran into a lake, submerging to the top of the cab. The bodies of the driver and one other person were recovered from the cab, and the truck removed from the lake. Twelve hours later the rear of the closed van was opened and it was discovered that 28 migrant workers had also drowned – apparently because rescuers had not thought to look for passengers riding in the closed van.
3) A husband and wife were transported by ambulance to the hospital emergency department after a single car accident. The wrecked vehicle was towed to a local garage. A final check was made inside the vehicle for personal belongings of the victims. An infant was found dead on the floor of the front seat. Apparently the child was forced up under the dash board area when the vehicle crashed. The jolting in transit to the garage shook the child loose from its entrapment.

Remember, make a thorough search of the accident scene, ask questions of the victims and bystanders as to the number of people involved. Victims are often thrown out of the car on impact, a small child could easily be overlooked.

Adequate provisions for debris, such as dirt, rocks, gravel, and miscellaneous spilled loads such as bottles, small boxes, hay, lumber, fruit and vegetables is a necessary functional capability for the extrication system. Usually, debris removal is considered to be a requirement for clearing the highway after an accident, but in some cases, access to the victim and clearance for removing him from the vehicle may require movement of surrounding debris. This will call into play certain rather unusual tools, such as shovels, pitch forks, buckets, hay hooks, as well as more commonly used extrication devices. For example chains, saws, and axes may be used to remove lumber, or a fire hose may be used to wash away sand and dirt. Special heavy duty construction type equipment, such as bulldozers, tractors, or dirt haulers, and dump trucks may be needed in order to effect a rescue. Such services should be pre-arranged through standby emergency agreements, or be available at the request of an official from nearby construction contractors, farmers, or industrial areas. This agreement is

Figure 60
Fold down roof section which provides a safe working area.

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best accomplished by developing a local disaster plan. Periodic practice drills should be carried out to simulate various disasters and familiarize each agency staff with their area of responsibility at the scene.

Figure 61
Tow trucks may be used to distort metal away from victim. Procedure should be carried out slowly to avoid further injury to the victims.

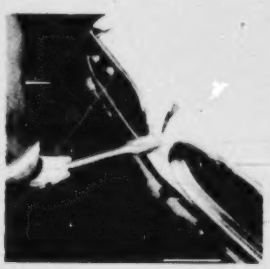


Figure 62
The hooligan tool may be used to pry open the hood.

Figure 63
Some rescue operators disconnect battery cables to lessen the chance of fire.

Summary of Functions

From the analysis of access and disentanglement procedures, it appears that there are major categories of functions which must be provided by the EMT extrication team. First, there must be a method for distortion of the automobile, usually back toward its original shape, but sometimes in other directions in order to effect a release and disentanglement. This method is highly desirable in general because it does not result in production of sparks, heat, or flame. Since it basically involves putting energy back into the structural system in a manner opposing that which was created by the crash conditions, very high forces may be required. At present, the most appropriate means for generating these high forces appear to be mechanical or hydraulic tools. Another obviously necessary functional requirement is that of severing or rending in which a hole or a slice is made in the structure. Generally speaking, the forces required to produce this severing, rending, or dividing action are somewhat less, since only local distortion of the metal is required. Automobile covering metal, largely or relatively thin gage, can be cut by high local pressures generated by a sharp-pointed instrument. The key to success in this operation is to find the weak points and attack them, generally leaving the distorted main structure with its energy frozen in. The basic disadvantages are that some of the severing methods create sparks from impact, grinding wheels, or saw blades. Also included in this category is the function of breaking, particularly in which glass is shattered for the purpose of gaining access.

Each of these major functions can be broken into smaller sub-functions for further detailed study. This has been done in Tables 1 through 3 which provide a listing of sub-functions, a detailed definition and application of each, and a list of suggested tools which provide the noted capability. General advantages and disadvantages of the respective functions and sub-functions are also provided for comparative purposes.

Another important function is that of displacement, in which parts of the vehicle, or items impinging upon it, are moved out of the way, either by lifting, pushing or pulling. Also, the vehicle itself may be lifted off a person trapped underneath it, or parts within the vehicle may be displaced relative to the main frame structure to provide clearance or an opening for access. Some of the methods employed for lifting and lowering can also be used in other phases, such as the transportation of the victim to the ambulance from a vehicle which is over the side of a cliff, or the lowering of a victim in a stretcher down to a waiting ambulance.

DESCRIPTION OF FUNCTION AND SUB-FUNCTIONS

Table 1
SEVERING, RENDING or DIVIDING

FUNCTION AND SUB-FUNCTION	DEFINITION	APPLICATIONS	GENERAL ADVANTAGES	GENERAL DISADVANTAGES	TOOLS AND/OR EQUIPMENT
SEVERING, RENDING or DIVINING	An operation of separating into two or more parts by incising or intersecting, piercing, penetrating, splitting, breaking, interrupting, cleaving, sawing, cutting, etc.	ACCESS to victim and DISENTANGLEMENT, or shortening or separation of penetrating objects from attachments; enlarging of structure for REMOVAL of victim	Positive removal of obstructions; no special assembly of components or fitting to structure required; rapid; low energy compared to crash input	Many methods tend to create sparks or heat; most are noisy; power supply may be heavy or complex; may be dangerous to personnel; may require support equipment	Refer to itemized sub-functions for specific items
Cutting	A combination of high local compression and tension, resulting in plastic flow and separation	Seat attach bolts, door hinges, gear shift levers, pedal shafts, small diameter rods, chain link fence, center divider cable, etc	No sparks; negligible heat generated	May be slow; limited area of application	Bolt cutter, manual Bolt cutter, hydraulic
Shearing	A combination of high local compression and opposite parallel translation of adjacent surfaces (shear) resulting in separation	Roof tops, door panels, other sheet metal sections, fabric liners, seat belts or restraint devices, etc.	No sparks, negligible heat generated, may require lower force than cutting	Useful only on relatively thin sections where good support of surfaces is possible; requires starting tool or opening made by other tool	Nibblers, electrical Shears, electrical or manual Sharpened leaf spring (plus hammer or mallet)
Chipping or Chiseling	A process of removal of multiple small pieces of material in a local area, by a gouging or splitting action	Seldom used in extrication	Low spark output	Slow action, usually noise and vibration	Pneumatic chisel (plus compressor or air tank) Hand chisel (plus hammer or mallet)
Sawing	A process of removal of a long narrow section of material using a multiple toothed blade performing a series of chipping actions, or an abrasive disc to effect material separation	Door posts, roof tops, door hinges, door panels, rods, rails, bars, posts	Fast, generalized usage; low force required	High spark and heat production, vibration, noise	Rotary blade saw, gasoline powered Rotary blade saw, electrical Chain saw, gasoline-powered Hacksaw
Grinding	Removal of material in a granular form, by friction In using a coarse stone or surfaced material, this is very similar to sawing	Same as sawing (some saws use a blade which is essentially a grinder)	Versatile, for small areas Low force required	Generally slower than sawing; high spark and heat production Vibration and noise	Rotary saw with abrasive disc Small rotary grinder (usually attachment on electric drill motor)
Puncturing	Piercing with a pointed instrument	Preparation for a shearing, chipping, cutting or pulling operation (starting hole)	Rapid means to make a hole	Limited to small area	Pick-headed axe Jumbo bar
Tearing	To separate or pull apart by force (may leave jagged edges, dependent on material being torn)	Seldom used	No sparks	Hard to gain purchase, required high force production	None identified

DESCRIPTION OF FUNCTION AND SUB-FUNCTIONS

Table 1
SEVERING, RENDING
or DIVIDING (Page 2)

FUNCTION AND SUB-FUNCTION	DEFINITION	APPLICATIONS	GENERAL ADVANTAGES	GENERAL DISADVANTAGES	TOOLS AND/OR EQUIPMENT
SEVERING, RENDING or DIVIDING (Con't)					
Burning	Removal of material by heating and combination with oxygen to form a gas; rapid oxidation of material at elevated temperatures	Access through major structure, doors, engine compartment, trunk, frame, etc.	Highly effective on metals Low force requirements Useful on distorted components where saw might not be practical	Flame-hazard of starting fires; heat-hazard of burning victim; bulky equipment; may be slow	Cutting torch, oxy-acetylene Burning bar
Breaking	Separation of materials by a sharp blow or other means, to cause embrittlement and overstressing without plastic flow	Window glass, concrete post or rail, stucco, wood entanglements, etc.	Rapid; low spark output; negligible heat	Missiles and sharp edges may result, uncontrolled forces	Axe Sledge hammer
Drilling	Making holes with a rotating edged or pointed instrument	Seldom needed	Low forces, no sparks	Some heat generated, limited use, may be slow	Power drill and bits

DESCRIPTION OF FUNCTION AND SUB-FUNCTIONS

Table 2
DISTORTION

FUNCTION AND SUB-FUNCTIONS	DEFINITION	APPLICATIONS	GENERAL ADVANTAGES	GENERAL DISADVANTAGES	TOOLS AND/OR EQUIPMENT
DISTORTION	To change shape in a plastic flow manner or other permanent manner, without severing or parting	To move portions of vehicle structure back toward their original position, or to a more open position, to create clearance or space for withdrawal of victim; GAINING ACCESS and DISENTANGLEMENT	Relatively quiet, non-sparking devices are used No vibration is produced by smooth application of force (hydraulic or manual)	High forces usually required in awkward places Relatively slow process, inaccurate and unpredictable movement may result	Refer to itemized sub-functions for specific items
Bending	To change radius of curvature of a component or structural member by mechanical force	Straightening door frame, raising roof or folding back roof for ACCESS	Frequently more rapid than cutting or sawing to obtain necessary opening; also used in conjunction with cutting or severing, where only portions of the component are severed	Usually requires reactive surface (or supporting surface); may be slow because of set-up time; protective devices may be required for trapped victim	Jack, hydraulic or mechanical Cribbing Hydraulic rescue kit and fittings Pry bar Hooligan tool Pliers
Prying	To cause local distortion of a structure by insertion of a sharp or thin tool, and exertion of leverage	Opening car door, raising portion of car or weight off victim, raising dash, opening space for other tools (alligator fitting, etc.)	Rapid method for performing some access functions. Versatile method of gaining access	Usually requires reactive surface or fulcrum; may require large force application; usually requires adequate space for sufficient leverage	Pry bar Tire iron Crow bar Hooligan tool
Spreading, Enlarging, Expanding	To spread apart. Usually will require deformation, yielding or separation of materials, principally the vehicle structure	To separate distorted components of vehicle structure; primarily DISENTANGLEMENT, some PREPARATION FOR REMOVAL and ACCESS	Frequently easier and more rapid than cutting or severing components to gain access or provide necessary opening or clearances for removal	Requires reactive surface or shoring to provide force application; may be slow because of set-up time	Hydraulic rescue kit and fittings Jack and cribbing Pry bar Hooligan tool Winch and cable w/associated hooks and/or fittings Block and tackle
Squeezing or Compressing	To draw together edges or ends of a structural member by compressive forces	To gain access to other components for subsequent operations (by other functions)	Infrequently used	May require large force application; requires reactive surface when compression effected by leverage	Pliers Pry bar Crow bar

DESCRIPTION OF FUNCTION AND SUB-FUNCTIONS

Table 3
DISPLACEMENT

FUNCTION AND SUB-FUNCTIONS	DEFINITION	APPLICATIONS	GENERAL ADVANTAGES	GENERAL DISADVANTAGES	TOOLS AND/OR EQUIPMENT
DISPLACEMENT	An operation whereby an object or portion of an object, is moved as a unit from its original position; motion can be in any plane; effect of force application on object is generally controllable; minor distortion may occur	Removal of debris or portions of structure to GAIN ACCESS; removal of wreckage for DISENTANGLEMENT, or removal of debris from victim; REMOVAL of victim from wreckage; TRANSPORTATION of victim from wreckage to ambulance	May be rapid and provide complete access and disentanglement, without requiring performance of other extrication functions	May require reactive surfaces; object(s) being displaced may tend to assume or pass through unstable positions, or collapse, with possible additional injury to the victim	Refer to itemized sub-functions for specific items
Push	To move an object, or portion of an object, from its original position by the application of a compressive force, usually in a horizontal or near-horizontal plane; contact between the object to be moved and that supplying the force is usually made prior to application of the force; force may be applied manually, or by a variety of tools or pieces of equipment	To displace vehicles, or portions of vehicle structure or debris, to gain access, and/or for disentanglement or removal of a victim	May provide rapid access to victim, as well as disentanglement, without requiring performance of other extrication functions (dependent on circumstances); generally, no sparks or heat are produced; variety of surfaces can be acted upon, by several methods	Traction or reactive surface may be required; set-up time may be lengthy; structure may deform or collapse, with possible additional injury to victim (dependent on circumstances); load distribution usually required to prevent unwanted deformations	Manpower Vehicles (various types) Jacks (various types) Hydraulic rescue kit Crowbar or pry bar
Pull	To move an object, or portion of an object, from its original position by the application of a tensile force, usually in a horizontal or near-horizontal plane; contact between the object to be moved and that supplying the force is made prior to force application and maintained during movement of the object; force may be applied manually, or by use of various equipment, through a connection to the object to be moved; occasionally, force applications may be applied in opposing directions to achieve separation of vehicles or structural components	To displace vehicles, or portions of vehicle structure or debris, to gain access, and/or for disentanglement or removal of a victim; frequently used for pulling driver's seat back, pulling basket litters up hillsides, separating vehicles or structural components, etc.	May provide rapid access to victim, as well as disentanglement, without requiring performance of other extrication functions (dependent on circumstances); generally, no sparks or heat are produced; variety of surfaces can be acted upon, by several methods; forces can be applied with power source remote from site of application; large forces can be generated, especially through small spaces or openings	Traction or reactive surface may be required; set-up time may be lengthy; structure may deform or collapse, with possible additional injury to victim (dependent on circumstances); judicious selection of structural component for attachment of pulling device usually required, to preclude additional structural failure or disengagement of pulling device under load	Manpower Vehicles (various types) Hydraulic rescue kit Winch and cable, with necessary hooks and/or fittings (winches may be power take-off, manual, or gasoline-powered) Block and tackle Hoists Crowbar or pry bar Slings Rope Chain

DESCRIPTION OF FUNCTION AND SUB-FUNCTIONS

Table 3
DISPLACEMENT
(Page 2)

FUNCTION AND SUB-FUNCTIONS	DEFINITION	APPLICATIONS	GENERAL ADVANTAGES	GENERAL DISADVANTAGES	TOOLS AND/OR EQUIPMENT
DISPLACEMENT (Continued)					
Lift (controlled vertical upward displacement) or Lower (controlled vertical downward displacement)	An operation frequently used in specific cases of pulling or pushing, involving movement of an object, or portion of an object in an approximately vertical upward or downward direction; lifting or lowering may be accomplished with a variety of tools or equipment through a range of distances, or manually in some instances	Raising of object positioned on or above a vehicle (including a vehicle above another vehicle), to gain access, and/or for disentanglement or removal of a victim; lowering a vehicle from an inaccessible position to a more suitable area (such as a vehicle through an overpass railing, and suspended, such that it is easier to lower than to raise), to gain access, disentangle and remove victim	May be only, or most rapid, method of providing access to victim, as well as method of stabilizing debris during disentanglement and removal of victim; frequently used in conjunction with performance of other extrication functions (dependent on circumstances); generally, no sparks or heat are produced; variety of surfaces can be acted upon, by several methods; forces can be applied with power source remote from site of application	Set-up time may be lengthy; structure may deform or collapse, with possible additional injury to victim; skilled operator required; judicious selection of structural component for attachment of lifting or lowering device usually required, to preclude additional structural failure or deformation, or disengagement of device under load	Manpower Vehicles (various types, but especially tow trucks) Winch and cable, with necessary hooks and/or fittings (winches may be power take-off, manual or gasoline-powered) Block and tackle Hoists Slings Rope Chain Timber-tripods or A-frames Jacks (various types) Crowbar or pry bar
Rotate	To move an object, or portion of an object, about a fixed axis, resulting in angular displacement of the object being moved, without significant translation	Opening car doors for access and victim removal (even with some structural deformation, doors can frequently be rotated, essentially about the hinge line): opening car roofs for access and victim removal (roof portions can be rotated after portions of supporting structure are served, or roof panel partially cut through). Rotation of vehicle upward about one side or end to provide clearance for access or disentanglement	May provide rapid access to victim without requiring performance of other extrication functions; may facilitate access, disentanglement and removal of victim when employed in conjunction with other functions, possibly minimizing degree of other functions necessary	Traction or reactive surface or anchor point may be required; structure may deform or collapse locally with possible additional injury to victim (dependent on circumstances); removal of other debris may be prerequisite	Manpower Protective garments (gloves, jacket, hard hat, etc.) Crowbar or pry bar (or various other bar tools) Power saw (or other cutting or severing devices) Hydraulic rescue kit Winch and cable, with necessary hooks and/or fittings (winches may be power take-off, manual or gasoline-powered) Block and tackle

In addition, a need for the following support functions has been identified:

Illumination	Debris removal
Fire suppression and prevention	Stabilization of vehicles
Protection of victim and rescue personnel	Disassembly
	Guiding and supporting

B. GROUPS II AND III – EMERGENCY MEDICAL CARE PROCEDURES

Considered from the standpoint of extrication, there are two different aspects to emergency medical care procedures. The aspect most directly related to extrication has to do with those necessary physical provisions and support devices which are attached to the victim(s) and which immobilizes them as a means of protection from further injury during removal and transport to the ambulance. Less obviously related, but very essential, are those emergency medical care procedures involving assurance of an airway, bleeding control, shock control and protection against contamination. Considered purely from the standpoint of access, disentanglement and removal activities, the majority of these resuscitation activities constitute necessary delays between various phases of the extrication process. However, taken together, the two groups of activities constitute the necessary total treatment of the victim during the extrication process and may be generally grouped under the title "emergency medical care procedures." Because these procedures are covered in detail in the "Basic Training Course for Emergency Medical Technician – Ambulance," this course on extrication will not consider them in great detail. The major purpose here is to emphasize those specific aspects which affect and should be part of the extrication process, in order that they may be accounted for in planning at the scene and in the training of personnel in extrication. Because of the extreme need for many of these procedures, cross-training and improved depth of training among the persons who may arrive at the scene of an accident is considered essential for improvement of emergency care systems. The following discussion will describe and evaluate some of these procedures.

1. Description and Evaluation of Emergency Medical Care at the Accident Scene

It is generally recognized that emergency medical care at the scene of an automobile accident often leaves much to be desired and in many cases directly contributes to the overall crash mortality. Much of this is due to the fact that relatively naive individuals are often first on the scene and undertake well-meaning, but inappropriate, actions such as pulling the victims from the vehicle or propping the head up to make the victim more comfortable disregarding a possible neck injury. One of the eight elements of the NHTSA Standard 11, Emergency Medical Services, encourages first aid training courses to be made available to the general public. A general and broadly disseminated public relations

campaign concerning "do's" and "don'ts" of emergency care at the accident scene would go a long way in educating the general public to what they may safely do and what they should expect from protective services, especially from the ambulance and rescue services. Particular effort should be directed toward tow truck operators since they are often first on the scene and are instrumental in accomplishing minor extrication procedures. These individuals should be considered a part of the extrication team, and should be encouraged to participate in auto extrication and emergency medical care training courses. This is particularly true in rural areas or in areas where extrication equipment may not be as extensive or as readily available.

The sequence of emergency medical care activity follows a well-accepted pattern. Breathing, circulation, bleeding, fractures, and shock should be considered, in that order. Remedial action should occur prior to removal of the victim and transportation to an ambulance unless the location of the victims is an area of imminent danger. The establishment of an airway and the control of severe bleeding are further defined as immediate, time-dependent problems in which expeditious handling directly influences survival. Experience has indicated that the immediate removal of victims from crashed vehicles is only warranted in a small percentage of cases. These cases are usually those where fire, or an additional hazard such as high speed traffic exists. Cases of submergence or presence of toxic fumes generally are rare, but consideration should be given to these conditions. Generally speaking, the victim will be better off inside the automobile enclosure until ambulance transportation is available. This is particularly true in inclement weather such as mist, fog, high winds, rain, snow or hail, and in hot desert sunlight.

The first aid programs of the American Red Cross are considered the national standard of training for the general public and are sometimes found to be the basis for preparation of ambulance and rescue personnel as well. This latter consideration was valid before the NHTSA's Basic Emergency Medical Technician training course was developed and a number of text books published specifically for the training of ambulance and rescue personnel. The NHTSA has followed the recommendations of the National Academy of Sciences, Committee on Emergency Medical Services when developing all its courses for the training of EMTs.

Because of the considerable differences in situations requiring extrication it is not practical to attempt to represent extrication procedures on a simple time-line chart or motion time study format. Instead, the presentation in Table 4 describes extrication procedures in terms of a modified computer program flow chart. *The rectangular boxes represent specific operations which may be performed* and *the "yes" and "no" points* represent decisions at which a selection among alternative possibilities for operations occurs. The flow of time generally proceeds from left to right. However, it will be apparent that there are several *logic loops* which may require a circular motion on the diagram. These loops are intended to imply possible repetitions until the requirements for completion of the task are met.

ARRIVE AT SCENE

ASSESS SITUATION

HAZARDS APPARENT	YES	NO
FIRE	✓	
TOXIC	✓	
VEHICLE LOCATION		✓
DEBRIS		✓
TRAFFIC		✓

YES → CONTROL HAZARDS

NO →

SUFFICIENT ILLUMINATION ?

NO → SUPPLY ILLUMINATION

YES → LOCATE VICTIMS

VICTIM ACCESSIBLE?

YES → (1)

NO → ATTEMPT ACCESS

SUFFICIENT TOOLS?

YES →

NO → OBTAIN TOOLS

RESCUER PROTECTION
VICTIM PROTECTION
VEHICLE STABILIZATION
DEBRIS REMOVAL
SEVERING
DISTORTION
DISPLACEMENT
DISASSEMBLY

NECESSARY ?

NO →

YES → PERFORM NECESSARY OPERATIONS

GAIN ACCESS

(1)

DISSENTANGLEMENT OF VICTIM NECESSARY?

NO → PREPARATION FOR REMOVAL

YES → ATTEMPT DISENTANGLEMENT

SUFFICIENT TOOLS?

YES → DISENTANGLE

NO → OBTAIN

PRELIMINARY LIFE SAVING ASSESSMENT DONE PRIOR?

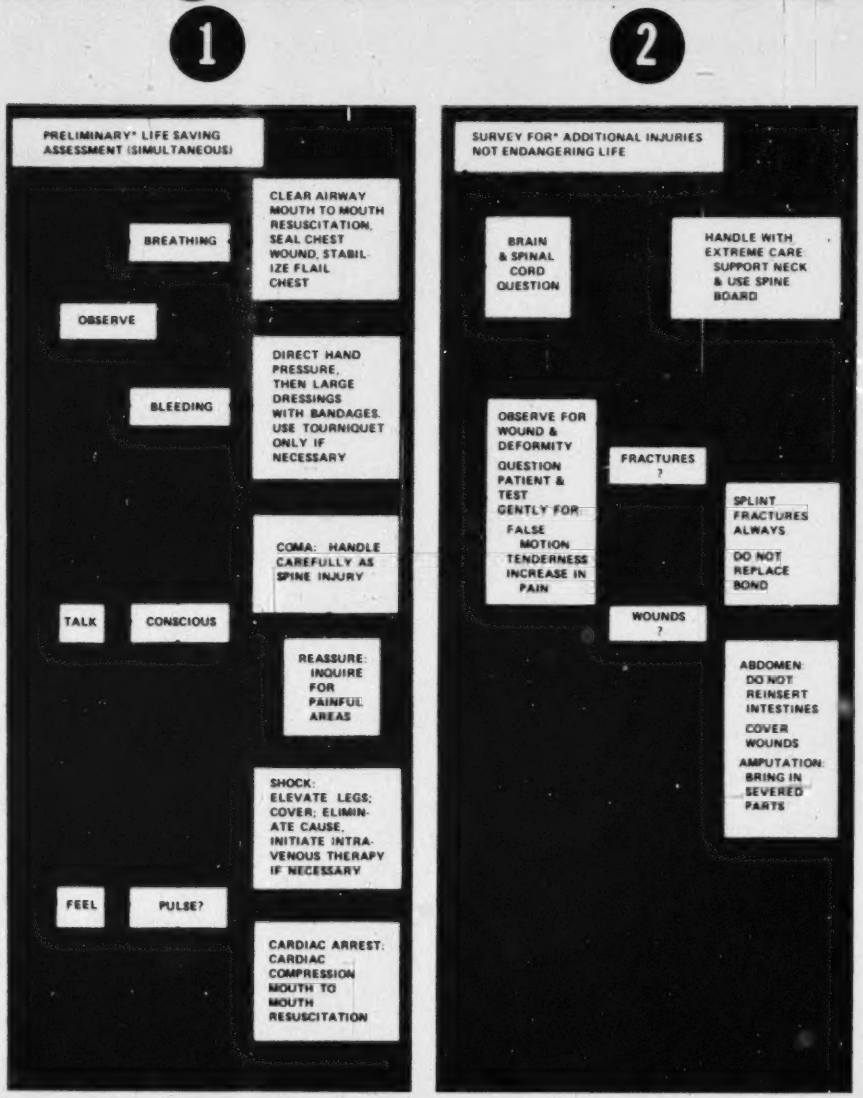
YES → (2)

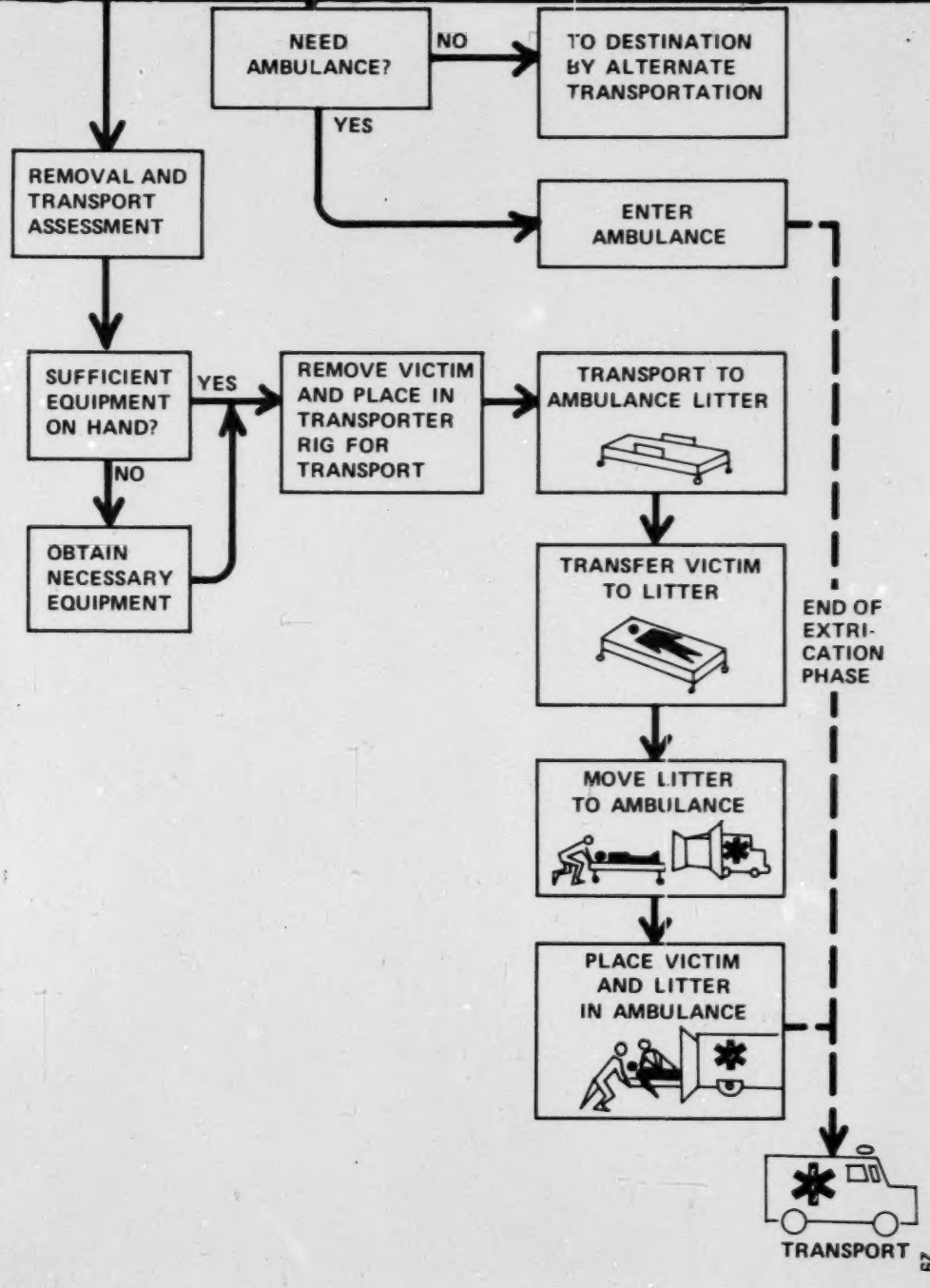
NO → (1)

AMBULATORY?

NO

YES


1
PRELIMINARY* LIFE SAVING ASSESSMENT (SIMULTANEOUS)
BREATHING
CLEAR AIRWAY MOUTH TO MOUTH RESUSCITATION, SEAL CHEST WOUND, STABILIZE FLAIL CHEST
OBSERVE
BLEEDING
DIRECT HAND PRESSURE, THEN LARGE DRESSINGS WITH BANDAGES. USE TOURNIQUET ONLY IF NECESSARY
COMA: HANDLE CAREFULLY AS SPINE INJURY
TALK
CONSCIOUS
REASSURE: INQUIRE FOR PAINFUL AREAS
SHOCK: ELEVATE LEGS; COVER; ELIMINATE CAUSE, INITIATE INTRAVENOUS THERAPY IF NECESSARY
FEEL
PULSE?
CARDIAC ARREST: CARDIAC COMPRESSION MOUTH TO MOUTH RESUSCITATION
2
SURVEY FOR* ADDITIONAL INJURIES NOT ENDANGERING LIFE
BRAIN & SPINAL CORD QUESTION
HANDLE WITH EXTREME CARE SUPPORT NECK & USE SPINE BOARD
OBSERVE FOR WOUND & DEFORMITY
QUESTION PATIENT & TEST GENTLY FOR
FALSE MOTION
TENDERNESS
INCREASE IN PAIN
FRACTURES ?
SPLINT FRACTURES ALWAYS
DO NOT REPLACE BOND
WOUNDS ?
ABDOMEN: DO NOT REINSERT INTESTINES
COVER WOUNDS
AMPUTATION: BRING IN SEVERED PARTS


NEED AMBULANCE?
NO
TO DESTINATION BY ALTERNATE TRANSPORTATION
YES
ENTER AMBULANCE
REMOVAL AND TRANSPORT ASSESSMENT
SUFFICIENT EQUIPMENT ON HAND?
YES
NO
OBTAIN NECESSARY EQUIPMENT
REMOVE VICTIM AND PLACE IN TRANSPORTER RIG FOR TRANSPORT
TRANSPORT TO AMBULANCE LITTER
TRANSFER VICTIM TO LITTER
MOVE LITTER TO AMBULANCE
PLACE VICTIM AND LITTER IN AMBULANCE
END OF EXTRICATION PHASE
TRANSPORT

The chart is limited to the description of procedures at the functional level, that is, specific tools are seldom mentioned, and details of tasks to employ the equipment are not included. This is necessary to avoid the overwhelming complexity which would be involved in a detailed presentation. The number of possible pathways would be extremely large if only the considerations for selection of tools for gaining access were shown. It is felt that the gross simplification of reality shown here is necessary and desirable to indicate the structure of the activity.

The chart, as shown, does not indicate the number of persons actually required to perform extrication. For simplicity, one may consider that it shows the procedures as if one person did the whole sequence. Actually, this is seldom the case, and different persons will perform some of the functions presented at different times, perhaps working together in some cases, perhaps doing separate jobs simultaneously in others, or merely waiting in other periods. Written and unwritten agreements in different jurisdictional areas will influence these decisions.

In analyzing the chart, it must be considered that some of the operations shown may not be performed in any observable sense, since they are only thought processes of the emergency medical technician. However, by assuming that some aspects of each operation may be at least considered and then perhaps actually combined with another operation, the chart may be greatly simplified by elimination of many alternate pathways. For example, in gaining access, one may consider any number of problems and hazards in a variety of orders, depending on the situation at the scene of the accident. In making up the group of possibilities, it was convenient to list them in order from top to bottom, but no priority is intended. It is assumed that the EMT, in effect, examines each one in turn until he reaches the one most necessary at the time of examination. He then performs that function and again searches the same list for the next most important function, and performs that one, continuing until all needed functions are accomplished. In a similar vein, steps in surveying the condition of the victim for viability and for determining what emergency medical care procedures are required are shown in a series. These activities were prepared as two sub-routines which may enter the extrication task sequence at a variety of points. Rather than repeat them each time, they are indicated as beginning with a numbered circle and ending with another numbered circle. These numbered circles are then noted as points of departure and return to the main sequence of activity as appropriate. However, the information has been re-cast into the program flow chart format for consistency and distinction between considered analysis and performance of identifiable tasks or operations.

One of the prime purposes of presenting the chart is to show that the emergency medical care procedures have a significant effect on other extrication activities and that the converse is also true. Emergency medical apparatus and supplies and usage will directly influence the extrication process. If they are not properly utilized, they negate gains from efficiency in removing the victim from the wreckage. It has been

considered useful to review briefly the major areas of concern in achieving victim stabilization with particular attention to those items which are germane to success in accomplishing the rescue when involving extrication.

2. Airway Requirements at the Accident Scene

Maintenance of an opened airway is a key element to victim survival at the accident. Loss of consciousness presents the potential for suffocation and requires the immediate attention of the first person to reach the accident scene. Extension of the head achieves a working airway in the majority of the uncomplicated cases with manual positioning of the tongue the remaining alternative. This may be accomplished by use of tongue forceps or insertion of an oropharyngeal or S-tube mechanical airway in an unconscious victim. Hyperextension is contra-indicated in event of cervical fracture and simple positioning cannot be assumed adequate in the event of maxo-facial trauma. This tends to suggest that a positive approach includes the automatic placement of an oropharyngeal airway in all cases of coma and serious facial injury. Caution should be taken in the use of this equipment as the placement of an oropharyngeal airway in a semi-conscious victim will more than likely invoke the gag reflex and regurgitation which may in turn lead to aspiration of gastric material and deterioration of the victim's condition.

The use of backboards should always consider the concomitant use of a mechanical airway and every effort should be made to accomplish prone or lateral positioning prior to transportation. The victim should never be left unattended in a supine position. With the unconscious person there is always the potential he may go into cardiac arrest, the backboard furnishes a firm support to carry out cardio-pulmonary resuscitations.

The need for constant victim surveillance is one of the reasons why an ambulance should not be overburdened with excessive extrication and miscellaneous equipment. There is a tendency for the crew to leave the victim unattended while they gather up and load the equipment onto the ambulance. The same applies to police operated ambulances. The police officer has many other responsibilities at the traffic accident scene, completion of accident report forms, obtaining statements from witnesses, traffic control, and measurement of skid marks, etc.

3. Basic Concepts of Bleeding Control

Injuries resulting from an auto accident generally incur some level of bleeding due to the immediate proximity of large amounts of glass, protuberances and torn sheet metal. Safety designs have tended to reduce direct exposure in the vicinity of the occupants, although lacerations will continue to occur as a result of dynamic contact with the interior surfaces. Bleeding may prove to be fatal if arteries are involved. Direct pressure and/or firm bandaging over an adequate dressing will control the majority of bleeding problems. The traumatic amputation is basically the only indication for tourniquet placement

with arterial bleeding from the neck presenting a unique situation which requires direct digital or hemostatic intervention. The development of individual skills which permit differentiation between insignificant and severe levels of bleeding are most important if efficiency is to be achieved at the accident scene. The inflatable splint is an important adjunct to the control of bleeding of extremities and is encouraged due to speed of application and the visibility that is retained following pressure application.

4. Significance of Shock at the Accident Scene

Shock must be considered an integral part of the symptomatology in an auto accident injury and should be controlled as a part of the overall emergency medical care plan. There are many causes of shock, but the clinical picture of the victim, in the majority of cases coming to the attention of the EMT, is very much the same. The victim is pale, his skin is usually cold, clammy and sweaty; he normally complains of being thirsty; is apprehensive; his pulse is rapid, weak and thready, and his blood pressure is low.

Whatever the cause of shock, the EMT should carry out a standard set of emergency medical care procedures, 1) raise the legs from the hips and keep the knees straight; 2) make certain the victim's respiratory passages are clear; 3) bleeding from external wounds must be controlled by pressure dressings; 4) all fractures must be immobilized; 5) if the victim is chilled, light blankets should be applied to maintain *normal* body temperature; 6) administer oxygen depending on the degree of shock, in severe shock the demand-type respirator will be the most beneficial; 7) talk to the victim, be reassuring, relieve his anxiety, and 8) observe and record all vital signs, stay with the shock victim at all times, he could go into cardiac arrest.

Military field practices and mountain resource activities have certainly validated the use of blood expanders on the single indication that severe bleeding has been incurred. Survival success has significantly increased with intravenous fluid therapy and few contra-indications are known to exist with respect to the auto accident victim. The EMT is permitted to administer intravenous fluids if he is so directed by a physician; it is encouraged that this item be routinely carried on the ambulance.

5. Mechanics of Emergency Fracture Management

Selection of splinting materials for the extrication process must take into consideration the prevalence of fractures in specific anatomical locations and the utility of those devices which comprise the operating inventory.

Cervical, lumbar, and femoral fractures comprise a significant portion of vehicular-induced fractures, and their immobilization requires a high level of preparation in terms of the equipment required at the immediate scene. Reliability of the splints must be high. The ease and rate of application within an adverse psychological and physical environment must be considered. The short and long backboards and

their numerous modifications, represents the basic concept of spinal immobilization. The value of all such devices rests on the basic premise of emergency splinting which holds that the only reliable means of achieving immobilization is to orient the fracture in specific proximity to a rigid object which is firmly anchored to two fixed anatomical points. This is the sole purpose of a splint, and if it does not serve this function, it is useless.

This concept becomes of major importance in the case of a femoral fracture. Not only should immobilization be achieved, but traction should be available and be utilized to counteract spasms of the injured muscle which may lead to arterial and neural involvement. This categorizes cardboard, fiber, and inflatable splints as final alternatives, and allows only wooden splints and splint boards to become an acceptable means of femoral immobilization. Immobilization of the leg due to a fracture of the femur is best accomplished with a half-ring splint, or with a long board splint reaching from the arm pit to the ankle if the victim is only a short distance from the ER.

The remainder of the extremities are aptly contained by the common methods of splinting which rigidly fix the broken member between two firm points. Recent improvements in the inflatable splint concept which have alleviated the problem of circulatory restriction, give this concept a definite advantage over other materials and methods relative to ease of application, and favor its expanded use by the various emergency services. Sudden changes in altitude and extremely cold weather may create some problems when using inflatable splints. Excessive pressure may build up in these cases requiring periodic checking by the EMT of the injured extremity and an adjustment made in the air pressure.

6. Preparation for Removal and Removal

The process of immobilization may be a deterrent to easy removal in some cases by making the victim a more bulky, less flexible "package" to pass through available openings. In such cases, another type of access problem exists. Enlargement of existing holes or provisions for lifting may need to be arranged using previously described tools and methods for gaining access. In other cases, the use of short backboards, long backboards, or other supportive devices provide handles and attachments which actually facilitate grasp and support during initial removal.

During or prior to the removal phase, some choice of pathway, method, personnel and equipment must be made. Plans and preparations for removal will have preconditioned these choices to a great extent. Therefore, these two phases should be considered together. For example, a decision to affix the victim to an angled body support or a backboard will possibly dictate enlargement of an opening, the placement of assistants in the vehicle and outside, or the location of the litter. Coordination between various rescue unit personnel should be by previous agreement.

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SEE PAGE 35

Figure 64

SEE PAGE 36

Figure 65

Figure 66
Work the long backboard behind the victim causing as little movement as possible.

Figure 67
Use sufficient sand bags and straps to prevent the victim from slipping.

a) Procedures Using Long Backboards

Backboards are usually fabricated from ¾" plywood finished on both sides. The surfaces should be well sanded, shellacked or varnished, and waxed. The strap and carrying holes on both the long and short backboards should be lined up to allow both boards to be fastened together. Two wooden runners on the bottom of the long board are recommended which elevates the board sufficiently for the rescuers to get their hands under the board to lift the victim and to facilitate sliding the board beneath victim. Specifications to construct the backboards are illustrated in Figures 64 through 65. The long backboard is used to stabilize a victim with possible back injuries from a lying position usually on the floor of an automobile. The backboard may be applied directly to the victim if there is sufficient room. Under these conditions where working space is cramped sand bags placed by the victim's head and body and secured with straps will prevent the victim from sliding from side to side during the extrication procedure. Illustrations of this procedure are provided in Figures 66 through 68. If there is not sufficient room to maneuver the backboard onto the victim the rope sling may be used to pull the victim in a straight line onto the backboard. If there is any doubt about a possible neck injury a cervical collar should be applied before the victim is pulled out by the rope sling. Figures 69 through 72 illustrate this procedure.

Figure 68
Ready for transportation – be sure to maintain adequate airway and be prepared to use suction equipment.

Figure 70
Position backboard as close to the victim as possible. A folded blanket may be placed under the victim's shoulders to facilitate this procedure.

Figure 72
Pull victim out onto the backboard in a straight line.

Figure 69
Long backboard cannot be applied directly to the victim.

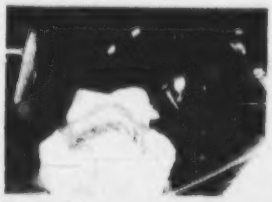
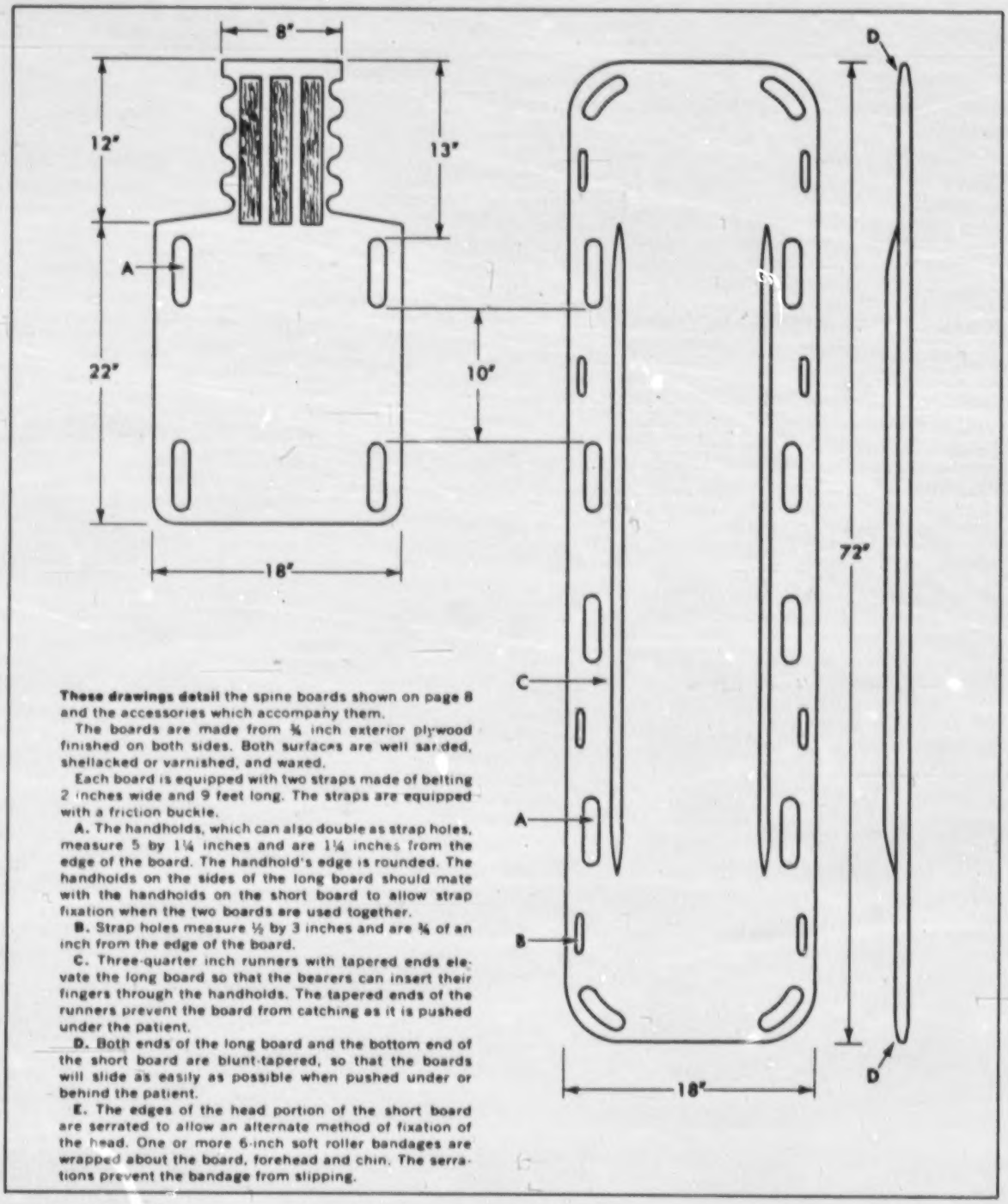


Figure 71
Apply extrication rope over chest and up the back of the victim's head.



These drawings detail the spine boards shown on page 8 and the accessories which accompany them.

The boards are made from ¾ inch exterior plywood finished on both sides. Both surfaces are well sanded, shellacked or varnished, and waxed.

Each board is equipped with two straps made of belting 2 inches wide and 9 feet long. The straps are equipped with a friction buckle.

A. The handholds, which can also double as strap holes, measure 5 by 1¼ inches and are 1¼ inches from the edge of the board. The handhold's edge is rounded. The handholds on the sides of the long board should mate with the handholds on the short board to allow strap fixation when the two boards are used together.

B. Strap holes measure ½ by 3 inches and are ¾ of an inch from the edge of the board.

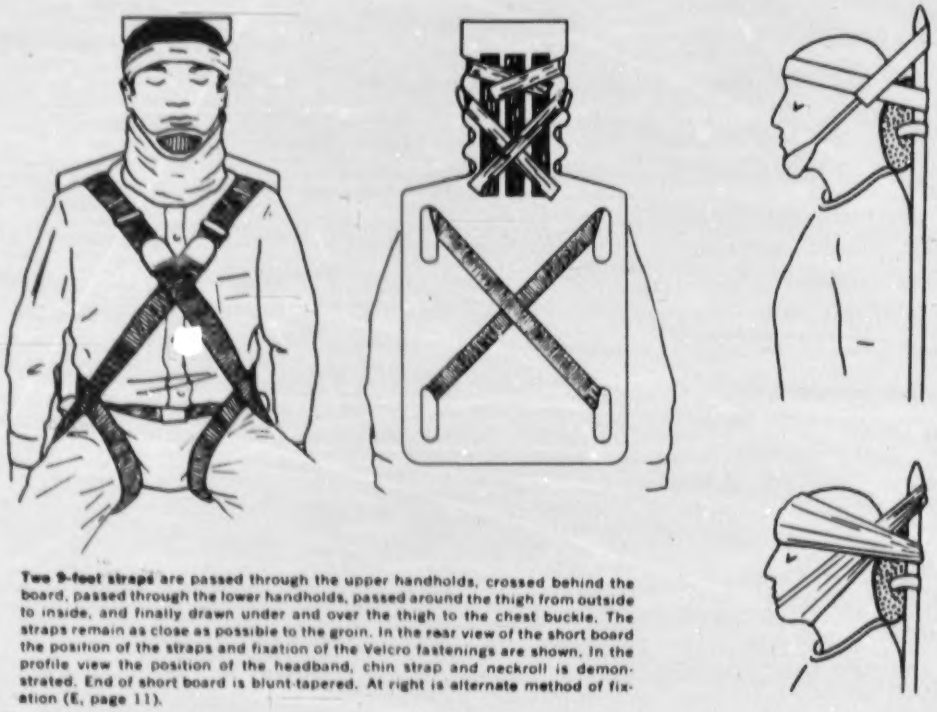
C. Three-quarter inch runners with tapered ends elevate the long board so that the bearers can insert their fingers through the handholds. The tapered ends of the runners prevent the board from catching as it is pushed under the patient.

D. Both ends of the long board and the bottom end of the short board are blunt-tapered, so that the boards will slide as easily as possible when pushed under or behind the patient.

E. The edges of the head portion of the short board are serrated to allow an alternate method of fixation of the head. One or more 6-inch soft roller bandages are wrapped about the board, forehead and chin. The serrations prevent the bandage from slipping.

Figure 64 American College of Surgeon's specifications for long backboard.

DESCRIPTION AND EVALUATION OF EXTRICATION METHODS



Two 9-foot straps are passed through the upper handholds, crossed behind the board, passed through the lower handholds, passed around the thigh from outside to inside, and finally drawn under and over the thigh to the chest buckle. The straps remain as close as possible to the groin. In the rear view of the short board the position of the straps and fixation of the Velcro fastenings are shown. In the profile view the position of the headband, chin strap and neckroll is demonstrated. End of short board is blunt-tapered. At right is alternate method of fixation (E, page 11).

Equipment for the short board consists of headband, chin strap and neck roll.

Headband (Fig. 1), which measures 42 inches, has:

a. Padded section;
b. Thin webbing 2 inches wide;
c. Strip of looped or pile Velcro.

Fig. 1

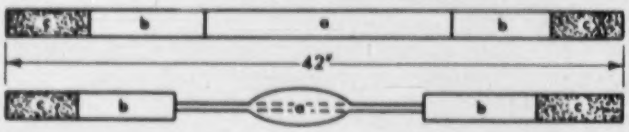
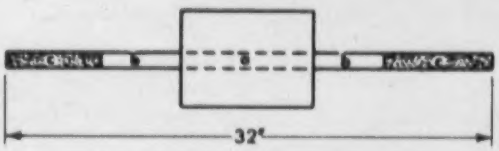


Fig. 2

Fig. 3



Chin strap (Fig. 2), which measures 42 inches, has:

a. Regulation football chin strap;
b. Thin webbing 2 inches wide;
c. Strip of looped or pile Velcro.

Neck roll (Fig. 3), which measures 32 inches, has:

a. Foam rubber roll 8 inches wide and 6 inches in diameter, covered for protection first with plastic, then stockinette, both disposable and easily replaceable;
b. Thin webbing 1-inch wide;
c. Strip of looped or pile Velcro.

Ends (looped or pile Velcro) of straps grab strips of Velcro with hook surface affixed to back of head piece on the short board.

The neck roll is seldom used. It is necessary in rare fracture-dislocations of the neck in which the head is fixed in an awkward position. A heavy folded towel will serve well as a substitute.

Velcro is a fastener. It consists of two strips of nylon tape—one covered with minute hooks, the other with minute loops forming a pile surface—which lock securely when pressed together, open when peeled apart.

Figure 85 American College of Surgeon's specifications for short backboard.

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Figure 73
Apply cervical collar – one EMT should hold victim's head until collar has been secured.

Figure 74
Slip short backboard behind the victim – base first.

Figure 75
Apply chin and head cravats.

b) Procedures Using Short Backboard

The short backboard is especially useful in preparing the victim for movement when he is found in a sitting position. With careful manipulation, the board may be slipped between the victim's back and the seat of the car with a minimum of disturbance to the spinal column. While the short backboard is being placed behind the victim the second EMT should hold the victim's head with slight traction in an upward position. The cervical collar is applied to the neck of the victim, and the board secured with straps. This procedure is illustrated in Figures 73 through 79.

All victims with suspected cervical or neck fractures will obviously not be found in a sitting position, some may be found face down on the floor of the vehicle. In these cases the short backboard should be placed against the victim's back over appropriate padding; the straps are placed around him and through the strap holes and secured. Chin straps and head bands should be used to hold the victim's head in a fixed position. The victim may then be lifted, turned over and placed on the long backboard, both boards secured together to allow for complete body support. This procedure is illustrated in Figures 80 through 83.

7. Transportation of Victim to Ambulance

Methods for transportation from crashed vehicle which may be a considerable distance from the highway, to the highway, and then to the ambulance, are of considerable importance in mountainous areas and even in freeway conditions where the highway is raised above the general surroundings. The most successful and least strenuous pro-

Figure 76
Secure cravat from upper right of backboard across chest to lower left of backboard.

Figure 77
Same but from left to right of backboard forming an X across the victim's chest.

Figure 78
Third cravat across chest.

Figure 79
Fourth cravat around abdomen and fifth secures the arms.

Figure 80
When victim is found face down, apply cervical collar.

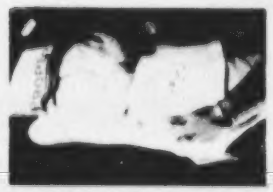

Figure 81
Apply proper padding.

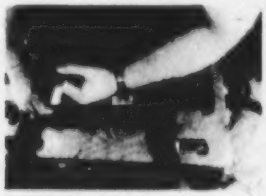

Figure 82
Apply half backboard.

Figure 83
Remove victim still face down – roll him over – release legs and place him on long backboard – *do not* remove short backboard.

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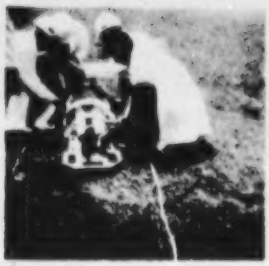

Figure 84
Secure victim with cravats or straps and sand bags to the long backboard.

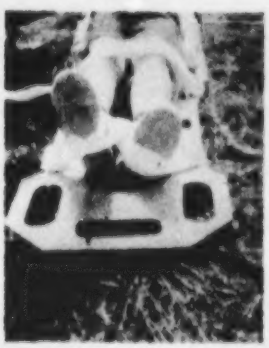

Figure 85
Cravats used to secure the victim to prevent sliding down on backboard while being transported up the hill.

Figure 86
The winch on the rescue vehicle provides the power to pull up the victim plus the four rescuers.

cedure appears to be the use of a winch and cable combination, from a rescue truck, ambulance or wrecker, with a rigid carrying device such as a basket type litter. However, several of the modified body support devices such as the orthopaedic type stretcher or long backboard could be used. The essential requirements are that there be a place to attach a lifeline to the head end of the litter such that it will take the stress of the victim's weight and that there will be adequate handholds along the side of the litter. An additional lifeline may be lowered along each side of the main line to provide for personnel assistance in climbing. The harness illustrated in Figures 84 through 86 is used by the Manassas, Virginia Rescue Squad which is a unique harness and very simple to construct. The load is applied evenly in the direction parallel to motion. The supporting rescuers hang onto the rope with the outside hand and hold up the backboard with the inside hand, thus they are aided in climbing the hill along with the rescued victim. During such operations, a means of signaling to the winch operator above, in case of problems of interference with rocks, shrubery, etc., should be provided. A portable hand held radio device which can communicate with a similar device at the winch end is used. Some rescue squads have designed a wire mesh hood over the head of the litter to add protection to the victim's face, and sled type runners to aid in pulling the litter over rocks.

The question of procedures, and/or difficulty of effort required, has importance with relation to the definition of extrication. In particular, it is questionable whether one should consider that there is an extrication problem if all the doors of a car are opened and there is no damage to the vehicle on the inside. However, the approach taken in this course of study is that if the persons inside cannot, by themselves, get out of the car safely, it shall be considered a matter of extrication and should be considered within the scope of this course. A similar problem arises at the other extreme of the situation, that is, how shall one classify the problem of removal of persons who have died in the process of the crash? Of course, the body must be removed for positive identification and other personal, health and legal requirements. This is a difficult technical point with legal implications for all EMTs. In some states no one is supposed to move deceased persons, particularly in an ambulance, until the coroner has given permission and made an inspection. On the other hand, EMTs are not expected to declare a person dead. These borderline cases must, in most cases, be treated as if they were extrication of live victims. It is not the purpose of this course to make the distinction. Of course, in actuality, every person involved in extrication makes his own judgment as to the relative chances of saving an individual or whether a particular method of life saving is appropriate in view of his own risk in performing the extrication activity under difficult situations. Therefore, in such obvious cases as decapitation, the techniques for extrication of the body may be considerably different than in cases of coma or unconsciousness without palpable pulse or breathing but wherein the body is essentially whole.

To help meet the need for advanced emergency medical care at the scene it is recommended that every ambulance and rescue service identify one or more on-call physicians. Many ambulance services throughout the country have worked out arrangements with local physicians to respond to the scene of serious accidents especially where victims are pinned in the vehicles and require more advanced emergency medical care than the EMTs are at present trained to carry out.

8. Functional Requirements for Emergency Medical Care Procedures

As a result of the foregoing analysis, a set of functional requirements has been derived. Those dealing primarily with the aspects of these procedures directly related to victim handling are described, defined and related to pertinent equipment requirements in Tables 5 and 6. In addition, the following functional requirements of a support nature have been identified for this group of phases:

Communication
Airway Provision and Resuscitation
Control of Bleeding, Bandaging, and Provision of Miscellaneous Emergency Medical Care
Shock Control
Comforting
Illumination
Visual Warning or Signaling
Protection of Victim
Protection of Rescuer
Debris Removal
Vehicle and Debris Stabilization
Severing
Distortion
Displacement
Disassembly
Power Supply and Transmission
Miscellaneous Functions

C. GROUP IV – SUPPORT FUNCTIONS

In the following paragraphs are considered the peripheral or support functions which assure that equipment and personnel arrive at the scene of the accident prepared to execute extrication activities, and that they are provided with the necessary information and protection during their activity at the scene of the accident. Specifically included are: dispatching and reporting, and hazard control. In addition to the functions clearly identified with these phases, other support functions common to several phases are discussed.

1. Reporting and Dispatching

Considerations of jurisdiction, of the proper methods of communication, and of the timing of calls for services, together with methods of detecting and reporting are all a necessary part of emergency medical

DESCRIPTION OF FUNCTION AND SUB-FUNCTIONS

Table 5
IMMOBILIZATION
OF VICTIM

FUNCTION AND SUB-FUNCTIONS	DEFINITION	APPLICATIONS	GENERAL ADVANTAGES	GENERAL DISADVANTAGES	TOOLS AND/OR EQUIPMENT
IMMOBILIZATION OF VICTIM	To prevent or reduce relative movement between body segments by securing them together or to a variety of rigid or semi-rigid devices	To prevent additional injury to victim, induced by movement of broken or displaced bones, during PREPARATION FOR REMOVAL, REMOVAL, and TRANSPORTATION TO AMBULANCE (and to medical facility)	Prevention of further injury to victim during movement of the victim; facilitates carrying injured if device provides handholds or permits easier grasping	May increase difficulty in removing victim through available access opening, or increase difficulty in lifting or handling victim	Refer to itemized sub-functions for specific items
Immobilization, Whole Body	To prevent or minimize relative movement between injured body segments (or where injury is suspected), by employing a rigid or semi-rigid device to restrict relative motion	To prevent further injury to victim during pre-removal, removal and post-removal activities by generally immobilizing the entire body, or immobilizing major body segments, such as head/trunk, trunk/leg, etc. (neck injuries, back injuries, etc.)	Prevention of further injury to victim during movement where injuries requiring whole body (or major body portion) immobilization are apparent or suspected	Large size or complexity of equipment required for whole body immobilization frequently makes insertion in vehicles difficult. May increase difficulty in removing victim through available access opening, or increase difficulty in lifting or handling victim	Backboard, long or short Chair splint Basket (Stokes) stretcher Orthopaetic or scissor type stretcher Frame canvas stretcher Pole and canvas litter Blanket rolls Collar splints Head bands Chin straps Straps (various types and sizes)
Splinting	To prevent or minimize relative movement between injured body segments (or where injury is suspected), by employing a rigid or semi-rigid device to restrict relative motion. This method of immobilization is used for limbs or segments thereof	To prevent further injury to victim during pre-removal, removal and post-removal activities by generally immobilizing limbs or portions thereof (arm or wrist injuries, leg or ankle injuries, etc.)	Prevention of further injury to victim during movement, where injuries requiring limb immobilization are apparent or suspected	May increase difficulty in removing victim through available access opening, or increase difficulty in lifting or handling victim	Half ring type traction splint Padded board splint Cardboard splint Inflatable splint Blanket rolls
Self-stabilization	To prevent or minimize relative movement between injured body segments (or where injury is suspected), by securing the injured member to another portion of the body. This method of immobilization is used for limbs or segments thereof, and is actually a special case of splinting	To prevent further injury to victim during pre-removal, removal and post-removal activities by generally immobilizing limbs or portions thereof, such as securing an injured leg to the other leg, securing an injured arm to the trunk, etc. This may be a temporary or intermediate method until victim is removed, when supplemental splinting can be applied if necessary	Provides an easy means to immobilize an injured limb for movement of a victim if suitable equipment is not readily available, or victim's body position precludes ready application of other splinting methods prior to removal; may be used to temporarily immobilize injured limb while access and disentanglement are being accomplished	May increase difficulty in removing and handling victim, since immobilization of injured member depends on ability of victim (and/or rescue personnel) to maintain degree of inflexibility of the body portion to which the injured member is secured	Straps (various types and sizes) Bandaging materials Miscellaneous articles of clothing (belts, neckties, handkerchiefs, etc.)

DESCRIPTION OF FUNCTION AND SUB-FUNCTIONS

Table 6
FACILITATION OF GRASP, GUIDANCE AND SUPPORT

FUNCTION AND SUB-FUNCTIONS	DEFINITION	APPLICATIONS	GENERAL ADVANTAGES	GENERAL DISADVANTAGES	TOOLS AND/OR EQUIPMENT
FACILITATION OF GRASP, GUIDANCE AND SUPPORT	Provision of devices and design features to facilitate rescuer operations of grasping victim, lifting, carrying or lowering him, sliding or directing pathway of motion	To assist in REMOVAL from difficult or inaccessible areas, and TRANSPORTATION TO AMBULANCE after removal	Prevents injury to rescuer from overstrain, reduces impact and abrasion of victim. Reduces needed number of men to accomplish removal in some cases	Requires additional time to prepare prior to removal or transportation to ambulance	Refer to itemized sub-functions for specific items
Facilitating Grasp	Any application of a device to the body of a victim or his supporting devices which provides one or more handholds or grasping surfaces for facilitating grasp by rescuers in preparation for moving the victim out of the vehicle or to the ambulance or other rescue vehicle	Primarily design features of victim immobilization devices which assist rescuers in carrying, lifting and lowering; handholds, loops, slings	Reduces danger of slipping or dropping the victim and reduces the danger of slipping or falling by rescue personnel	May increase overall size of item for stowage and usage	Belohlavek apparatus Rope sling Long backboard (with handholds) Short backboard (with handholds) Orthopaedic or scissors type stretcher Basket (Stokes) stretcher Winch board sling Basket litter sling
Guiding and Supporting	Providing guides or manual supports and direction for the victim's body or rescuers to assure a smooth pathway during movement (displacement) from the auto or area where the victim was trapped. Manual help is included	Sliding victims out of automobiles or from under them. Assisting rescuers in carrying victims to ambulance	Prevents additional pain or injury from impacts, bending of body	Requires additional time for care and preparation	Winch board Backboard Belohlavek harness Basket litter sling

care extrication services, and are generally classified under the heading of communications. Communications may be classified according to the type of information which is contained within the signals. Functionally, information content appears to be more important than the technique by which it is transmitted for purposes of discussion in this extrication course. For the most part, two-way radio, voice and telephone are the normal expected modes of communication. Occasionally, new or somewhat different methods may be used. As noted during the discussion on gaining access and transportation to the ambulance, the need for a voice gun may be apparent for calling signals to persons moving individuals up the side of the hill, down a steep cliff, off a freeway bridge, or for crowd control. The first order of business in communications area deals with notification of occurrence of an accident to the appropriate authorities who may order the rescuing personnel and equipment to the scene of the crash. In order to accomplish this most rapidly, two avenues are open. One has to do with the use of automatic crash detection devices, in the automobile, which would be monitored on central receiving sets in the local control centers. The other has to do with the possibility of detecting such incidents on the highways by automatic or human surveillance systems. It appears desirable at this point to provide a capability for vehicles to have an automatic crash impact detection system. The details of the system design are not considered here, but the major purpose is to provide for a short response time by rescue personnel. Response time is that time period between the time the call is received by the dispatcher and the time the emergency vehicle arrives at the accident scene. Unfortunately, the need for such a device increases as its capability for implementation decreases. That is, the rural areas are those in which an automobile passenger or driver can be in serious trouble for the longest period of time before detection. Also, these areas are usually the poorest in terms of income and capability for supporting a central monitoring system. Furthermore, the capability of the system to transmit from the automobile over longer distances must be greater to be effective. Nevertheless, it appears perfectly feasible within cost and state-of-the-art constraints to provide such a system.

The next point of information transfer occurs when a passerby in an automobile, or other vehicle, notices the accident and communicates it to an appropriate authority. A variety of means is available at this point. Cars which are equipped with amateur radio transmitters may be enlisted to transmit information by providing a signal along the roadway with the proper call letters. Call boxes can be provided at reasonably spaced intervals along the roadway, especially in freeway areas and in large cities so that information may be called in about the accident. The call box system to be most effective should provide two way voice communication. Police and law enforcement vehicles should be equipped with two-way radios to notify ambulance, rescue services and fire department or other emergency services of the need for their presence at the crash scene. Fire departments, rescue vehicles, and ambulances should be equipped with two-way radios connecting to their stations, dispatching points, hospital emergency departments, and

to police stations to pick up information. A central county dispatching service is generally useful and recommended. Details of such systems are not considered herein as they are described in full detail in, NHTSA publication, *Communications – Guidelines for Emergency Medical Services.*

The biggest problem in the extrication process is providing the right kind of trained personnel, equipment and amount of equipment at the right time at the scene of the accident. This may be greatly aided by the kind and amount of information transmitted at the time of the discovery of the accident. A course of instruction for the dispatcher has been published by the NHTSA titled, *Dispatcher – Emergency Medical Technician – Training Course*, which should be of benefit to the dispatcher in securing the essential accident data and providing to the caller directions that could be life saving to victims in life threatening situations. It could be expedited by notices on call boxes, pay telephones, by instructions to police, and by instructions to operators. Beside facts as to location of the accident, information should be transmitted as to the number of persons who appear to be injured and who would require emergency medical care, and the amount of vehicle damage and its final resting position. A simplified classification scheme is suggested in the following section dealing with extrication problems and appropriate tools. There is a strong indication that communication between the doctor in the hospital emergency department, the fixed-base station, and the EMTs at the scene of the accident would facilitate handling medical problems and increase efficiency of personnel.

2. Transportation to the Scene of the Crash

The first item of priority, with regard to protection of the individual, is emergency medical care. The major responsibility for emergency medical care generally lies with the ambulance and rescue teams although personnel of any type who are properly trained should render life saving care if they are the first at the accident scene.

Second, is the agency which will perform the majority of the extrication process delegated this specific responsibility? Are the personnel offered training which identifies them as part of the EMS team? This will commonly be a volunteer rescue squad or fire department, but a variety of other agencies may be provided with large, forceable entry tools. On the open road the problem of traffic is not often great, but on freeways the road is often quickly filled bumper to bumper with cars at the scene of an accident. Rescue vehicles must attempt to approach the scene of the accident as closely as possible with a minimum of time loss. Sometimes, this means that they may not reach the level of the road itself, (especially on a freeway) and must arrive on a cross road or a parallel road from which rescuers climb to the accident scene. Ladders or cable arrangements, may be required to bring extrication equipment to the actual scene of the accident. It would appear that a light-weight vehicle with narrow dimensions would be more useful in many extrication activities rather than a heavy crash

truck. Perhaps in some cases a motorcycle would be appropriate for the purpose of delivering a trained EMT to the scene to begin emergency medical care of the injured. The full hook and ladder truck has a valuable resource in its extendable ladder which can be used as a boom. Also, a heavy utility tow truck or the standard tow truck with a boom and a winch on it can be of great assistance. Some of these vehicles are often available at the scene of the crash.

The selection of a system of organizational jurisdictions is related to the whole range of rescue activities. The program of training for personnel must also be considered. Financial assistance for the establishment and conduct of training courses for ambulance and rescue personnel may be obtained through the official state EMS coordinator under Standards 11 and 16 of the Highway Traffic Safety Act. The overall basic philosophy for each government organization is another serious factor for consideration. The influence of a few key personnel may highly motivate certain groups to provide combinations of services that might be completely unattainable in other areas. Legislation may be required to make certain changes. Psychological and physical resources should be studied to determine the optimum distribution of services for any given region.

3. Traffic Control Procedures

Various aspects of traffic control procedures have been mentioned in preceding sections and evaluated with regard to extrication activities. It is not considered useful to repeat these observations here. Reference is made to the section on the description of the accident scene (Section V), and to the preceding paragraphs on problems of rescuers in approaching the accident scene. From such considerations, it is clear that the following functions are required:

Communication
Illumination
Visual Warning and Signaling
Fire Suppression and Prevention
Protection of Victim (from Impacts)
Protection of Rescuer (from Impacts)
Debris Removal
Power Supply and Transmission
Displacement (of vehicles, etc.)

4. Hazard Control

Hazard control is a concept involving activities related to extrication in various different ways. This relation may range from the general hazard control of the overall area, such as a spilled fuel condition or an unsafe bridge, to the possibility of particular injury to an individual at the point of disentanglement from a vehicle. The primary problem is spilled fuel at the scene of the crash. Fire prevention is usually performed by washing down the area with a fire truck pumper unit having sufficient tankage. Usually about 100 gallons of water is sufficient for wash

down. The use of water is the simplest and cheapest method for preventing the possibility of ignition during the extrication process. Alternate capabilities are foam and "light water" suffacant chemicals, dry powder and CO_2 blankets of various types.

Other types of hazard control involve *protection* of personnel from sparks and metal chips during the processes of severing, bending, and distorting the automobile or other vehicles. These types are considerably different in order of magnitude and must be considered separately as far as ranking procedures. Basically, they are protective devices or shields instead of active agents working to put down or suppress flame. Items, such as wool blankets, reflective blankets, or asbestos blankets may be considered in the category of protective gear.

Other hazards which should be considered, are hazards to the operator, not from flame, but from missiles and sparks. Clothing of various types are effective here, and the use of guards, masks, goggles, helmets and boots should be considered. If a cutting torch is being used, the type of goggles required is somewhat different from those to be used in saw work because of the possibility of ultraviolet radiation damaging the eyes.

An area of concern in hazard control is that of hauling the victim up the side of a hill through brush and trees. The device in which he is raised is usually a basket type litter. This device provides protection of a sort, and aids splinting action and stabilizing or immobilizing of the victim. It does not, however, provide adequate protection from scratching, puncture wounds and dust or dirt falling into the victim's face. Therefore, a covering over the basket is useful for this operation. General purpose flood lighting also performs a safety function. Without such lighting, one could fall into ditches, off cliffs, step into dangerous fuel or toxic materials, or bump into sharp or puncturing edges and receive severe wounds. Fumes and smoke may be a problem in accident situations, and gas masks or self-contained air packs may be required by the rescuing group and for the victim. It should be noted that as a result of a change in the National Fire Protection Association, Standard No. 19, Chapter 9, the filter canister mask for fire fighter use was eliminated. NFPA Standard No. 19B recommends that only self-contained apparatus with a minimum half hour duration rating be used.

Extrication may involve requirements for stabilization of debris or vehicles prior to attempting the rescue of the victims. In some cases, land-slides and snow-slides may create a hazard because of continuing movement while the victim is being removed from a vehicle. Stabilization then becomes, in effect, protection for both the rescuer and the victim. Occasionally, a vehicle will be in a precarious position, such as overhanging a bridge or coming to rest upon loose soil or gravel which could result in further movement of the vehicle and further injury to the victim. Stabilization of vehicles and some materials may be achieved by use of various chains, cables and other anchoring methods prior to attempting rescue operations. In general, devices of this nature are also devices which are useful for lifting, lowering, pushing or pulling on

vehicles or debris in other classes of extrication problems. Therefore, in evaluating tools, a major concern in relation to this stabilization function is to point out these duplicate or overlapping usages of certain tools to assure that these additional capabilities receive proper consideration during selection for an extrication system. A duplicate listing of such tools, however, does not appear warranted to emphasize this point.

Some cases of stabilization are actually a special static case of one of the displacement functions. The prime area of exception appears to be that where shoring or cribbing of some type must be applied to a body of debris to prevent its further movement during extrication. For such purposes, a set of stout posts and planks, together with means to secure them together, appears to be the most efficient and versatile equipment. The portable hydraulic rescue kit can be effectively used for temporary shoring procedures. By placing a heavy plank at each end and providing extender bars to the appropriate length, a diagonal bracing arrangement can be achieved.

Functions of hazard control will depend on the situation, but they may include the following:

1. Fire Prevention
2. Fire Suppression
3. Debris Stabilization
4. Protection
5. Anchoring of Vehicles
6. Shielding
7. Diverting of Water or Other Fluids
8. Smoke Control or Fumes Removal

5. Other Support Functions

Devices to supply and transmit power are essential for operation of many items of extrication equipment. The types of power sources selected determine, to a large extent, the necessary procedures and types of tools which can be used during the extrication process. Power supply and transmission methods further determine the range of usefulness of certain tools in terms of distance from a rescue vehicle. Also affected is the weight of the equipment which must be carried, the access space which is required to apply tools and equipment, the time required to perform various operations, and the overall cost of the system.

It has been convenient to include hydraulic systems in this consideration, although a hydraulic device is merely a mechanical force multiplier rather than a true power source. However, this mechanical advantage is of a magnitude so much greater than that which can be applied manually, that it is similar to a power device. For example, the effort involved in holding a power saw to a door post and letting the gasoline-powered motor turn the blade is not much different from the relative effort in pumping the hydraulic fluid manually in a hydraulic rescue kit. Therefore, a category of power supply and transmission used

herein is referred to as a manual-hydraulic. Of course, other power system combinations are possible. A hydraulic lifting device very often is powered by a compressor, or an electric power take-off from a gasoline engine, through a pump to supply the actual lifting force. Therefore, these systems are categorized under other combination power sources. Generally speaking, gaining access and disentanglement by manual-hydraulic means is recommended to reduce the danger of sparks and the psychological fears associated with noise and possibilities of pain and further injury due to vibration which may be induced by other devices. However, under some circumstances, these risks of gasoline-powered devices, saws, and cutting tools are considered acceptable, particularly when sufficient fire-fighting equipment is available.

Analysis of the procedures in the support function which have been presented in the foregoing paragraphs has led to a tabulation of functional requirements which is presented in Tables 7 through 12. In addition, the following functional requirements have been identified and discussed: Communications, Travel, Vehicle and Miscellaneous Functions, Vehicle and Debris Stabilization, and Debris Removal.

D. SUMMARY – FUNCTIONAL REQUIREMENTS

The foregoing discussion of the various procedures in the extrication process has indicated that a variety of functional capabilities is needed for each phase or group of phases in the extrication process. It was obvious that the functional requirements were duplicated in different groups of phases. In Table 13, a complete listing of the functional capabilities for extrication which were derived in the foregoing discussion is presented in the column on the left hand side. In the group of column headings across the top, is presented the list of phases in the extrication process. The requirements for functions in each phase are indicated by an "X" in the appropriate column for each function. The ordering of functional capabilities in Table 13 is approximately in the order in which these functions are required during the extrication process. It may be noted that the support functions tend to be more generally required throughout the extrication process, particularly the functions of communications, illumination, and power supply and transmission. For each functional capability defined, it is indicated that there are required tools or equipment for performing the function during the extrication process.

Although there has been some mention of agency responsibilities during this discussion, it may be seen that these functional requirements are essentially independent of agency organization as to their actual need during the extrication process. A wide range of options is still open to local governments for organizing and equipping various agencies to perform the required functions. Similarly, a wide range of options is open concerning equipment which may be purchased to aid in performing these functions. It would appear that a local government may elect to combine the extrication functions in any manner which it so desires, in accordance with personnel and traditions. However, there

DESCRIPTION OF FUNCTION AND SUB-FUNCTIONS

Table 7
ILLUMINATION

FUNCTION AND SUB-FUNCTIONS	DEFINITION	APPLICATIONS	GENERAL ADVANTAGES	GENERAL DISADVANTAGES	TOOLS AND/OR EQUIPMENT
ILLUMINATION	Provision of general or specific illumination of accident scene, for night usage or under adverse lighting conditions	Provide illumination for GAINING ACCESS, DISENTANGLEMENT, PREPARATION for REMOVAL, REMOVAL, RENDERING AID, TRANSPORT to AMBULANCE, HAZARD CONTROL, and possible TRAFFIC CONTROL	Essential for performance of accurate, effective extrication operations at night, or under adverse lighting conditions	May require support equipment for power supply	Refer to itemized sub-functions for specific items
Flood Lighting	Provide wide-angle, relatively uniform, artificial lighting for general work area illumination	Provide general illumination for ACCESS to VICTIM, DISENTANGLEMENT, PREPARATION for REMOVAL, REMOVAL, FIRST AID, TRANSPORT to AMBULANCE and HAZARD CONTROL	Essential for night work, or under conditions of low ambient lighting	Illumination may not be directly available in enclosed work area; portion of vehicle structure or rescue personnel may obscure light	Vehicle headlamps Floodlight, vehicle mounted Portable light, battery powered (wet or dry cell incandescent, or dry cell fluorescent) Portable light, connected to auxiliary power source (generator, AC or DC outlet, etc.) Extension cords Tripods or light stands
Spot Lighting	Provide narrow, generally high-intensity beam, of artificial lighting for specific work site illumination	Provide specific illumination for ACCESS TO VICTIM, DISENTANGLEMENT, PREPARATION for REMOVAL, REMOVAL and FIRST AID	Essential for night work, or under conditions of low ambient lighting, where specific high-intensity or concentrated illumination is required, or where illumination is required over a relatively long distance	In general, may require greater portability than flood lighting; portion of vehicle structure or rescue personnel may obscure light	Vehicle headlamps (high-beam) Spotlight, vehicle mounted Spotlight, portable (battery powered or connected to auxiliary power source.) Flashlight Penlight Extension cords Tripods or light stands

DESCRIPTION OF FUNCTION AND SUB-FUNCTIONS

Table 8
VISUAL WARNING
AND SIGNALING

FUNCTION AND SUB-FUNCTIONS	DEFINITION	APPLICATIONS	GENERAL ADVANTAGES	GENERAL DISADVANTAGES	TOOLS AND/OR EQUIPMENT
VISUAL WARNING AND SIGNALING	Provision of general or specific illuminating devices to provide means of information transmittal, regardless of ambient light levels (i.e., night or daylight activities)	Provide means for warning or signaling for TRAFFIC CONTROL purposes, or as advisory for HAZARD CONTROL under various situations	Essential for altering traffic flow of hazardous or abnormal highway situations, and as a means for providing control of traffic	Dependent on several factors, warning or signaling devices may not be readily observed until in close proximity	Refer to itemized sub-functions for specific items
Warning Lights	Flashing or rotating lights, usually red or yellow, are used to alert motorists to possible danger. This type of light is usually a high-intensity light, where red usually denotes "danger" and yellow signifies "caution"	Provide means of alerting traffic flow to possible hazardous situation, or advise of presence of emergency vehicles	Essential for advisory means of alerting motorists to hazardous or adnormal highway situations, or the need to provide access for emergency equipment	Depending on terrain, structures, traffic congestion, weather and other factors, vehicle-mounted warning lights may not be readily observed until they are in close proximity to the motorist	Vehicle-mounted flashing or rotating light (usually red or yellow). Strobe light Flashlight Beacon lights (portable or fixed)
Signaling Lights	Illuminating device to provide visual information transmission	Provide signaling means for control of traffic at an accident site or location of hazardous highway situations. Provide means for signaling or transmitting information between remote or separated rescue/ emergency equipment personnel	Necessary for providing advisory instructions to maintain traffic control, especially at night or under low levels of ambient lighting. Also provides readily available signaling means for remote or separated rescue personnel, in absence of voice communication devices	Requires personnel for manipulating light for traffic control (this is not a disadvantage if sufficient rescue/ emergency personnel are available)	Flashlight (conventional) Flashlight, signaling type (with translucent red shroud) Portable lights (various types)
Warning Flares	Pyrotechnic devices, usually high-intensity red, are used to alert motorists to possible danger or hazardous highway situations. These are usually deployed at the site as well as in advance of the hazard, to alert oncoming traffic at some distance from the actual hazard	Provide means of alerting motorists of hazardous highway situations, or as an advisory means to slow the flow of traffic (as in the case of a disabled vehicle on or off the highway). Flares are normally placed on highway after ignition	Desirable for providing an advance means of alerting motorists to hazardous or abnormal highway situations, by strategic placement of several devices toward the direction of oncoming traffic	Flares are frequently too low to be readily seen under many circumstances (traffic congestion terrain, etc.). Frequent replacement necessary, because of rather brief duration of burning. Cannot be used in presence of spilled fuel (fire hazard)	Pyrotechnical flares (red)

DESCRIPTION OF FUNCTION AND SUB-FUNCTIONS

Table 9
FIRE SUPRESSION
and PREVENTION

FUNCTION AND SUB-FUNCTIONS	DEFINITION	APPLICATIONS	GENERAL ADVANTAGES	GENERAL DISADVANTAGES	TOOLS AND/OR EQUIPMENT
FIRE SUPRESSION and PREVENTION	To extinguish or reduce and control intensity of a fire, or prevent occurrence of fire	To control flame resulting from crash, usually due to ignited fuel spilled from vehicle, or inhibit start of fire	Enhance survival of victim, and/or enable safe performance of extrication operations by rescue personnel	Division of resources is required	Refer to itemized sub-functions for specific items
Smothering	To reduce availability of oxygen to area of combustion, without special attempts to cool combustibles	To control flame resulting from crash, usually due to ignited fuel spilled from vehicle	Primarily best for electrical fire. Also useable on other types of fires	Flame may flare when the smothering agent is removed or dissipated	CO_2 fire extinguisher, portable stand portable backpack "Light water" chemical fire extinguisher Asbestos blankets Sand bags
Smothering and Cooling	A combination of oxygen reduction and cooling of combustibles	To control flame resulting from crash, usually due to ignited fuel spilled from vehicle	Good for wood, fiber and fuel fires	Smothering agent may damage materials and present other hazards (i.e., toxic fumes, etc.)	H_2O fire extinguisher (portable or vehicle mounted) Chemical extinguisher (dry powder or liquid) Foam fire extinguisher Fog fire extinguisher
Wash Down	Flooding an area with a stream of water	To wash away fuel in area of crash to reduce fire hazard	Reduces hazards in area of crash; inhibit start of fire	Ice formation in cold weather Electrical shock hazard	Vehicle, water, pump and hose

Table 10
PROTECTION OF VICTIM

DESCRIPTION OF FUNCTION AND SUB-FUNCTIONS

FUNCTION AND SUB-FUNCTIONS	DEFINITION	APPLICATIONS	GENERAL ADVANTAGES	GENERAL DISADVANTAGES	TOOLS AND/OR EQUIPMENT
PROTECTION OF VICTIM	Any procedure or device which provides a shield or counteracting agent against a recognized hazard, but primarily those means involving intimate contact to the body or within a close proximity	GAINING ACCESS, DISENTANGLEMENT, PREPARATION FOR REMOVAL, REMOVAL, TRANSPORTATION TO AMBULANCE, general protection of victim, RENDERING AID	Protection of victim; prevent further pain or injury during extrication operations	Time to prepare protective devices	Refer to itemized sub-functions for specific items
Heat Protection, Passive (Insulation)	Thermal insulation by blanket or other covering material, to prevent excessive heating or burning of victim (caused by operation of tools performing extrication functions)	Personnel protection during use of heat-producing tools, such as rotary saw, cutting torch, etc.	Prevent burns on victims, or pain caused by heat; reduce liquid loss; prevent heat-induced stress	None identified	Blanket, asbestos Blanket, wool (wet) Canvas
Cold Protection, Passive (Insulation)	Thermal insulation by blanket or other covering material to prevent excessive cooling of body	Personnel protection during cold weather, to provide comfort and prevent freezing or chilling	Prevent chilling or freezing, provide comfort to victim	Requires body heat	Blankets, wool Sheets Pillows Blankets, paper or fiber
Cold Protection, Active	To provide heat by an active agent or device, such as electricity or combustion	Protection and warm up during extremely cold weather; warming victim by direct heat, hot drinks or space heating	Prevent freezing or chilling; provide comfort to victim	Availability or set-up time of equipment; danger of open flame if spilled fuel present	Gasoline stove Heating pad, electric Heating pad, chemical (oxo-thermic, activated by addition of water) Hot water bottle Space heater, electric or gasoline
Missile and Spark Protection	Provision of shielding against flying particles, burning particles or sparks	During phases of gaining access and disentanglement, provide protection against burning by torch, sparks generated by use of gasoline powered saw, etc.	Prevent injury by impact or burning	None identified	Blanket, asbestos (wetted)
Rain, Sleet and Snow Protection	To provide water proofing and prevention of heat transfer by a suitable covering	Protection of victim during inclement weather	Prevent chilling and general discomfort to exposed victim	None identified	Salvage cover Tarpaulin, canvas or rubber Plastic sheeting Vehicle
Protection against Acids and Corrosive Chemicals	Provision of a shielding device or a counteracting chemical agent to protect against corrosive action of chemicals	Primarily (most frequently) protection from dripping battery acids; on occasion, protection is required against corrosive toxic chemicals in tanker truck accidents	Prevent further injury to victim	None identified	Water proof tarpaulin Absorbent materials (blankets, pads, etc.) Chemical agents Hose and water supply to wash away or dilute corrosive or toxic spilled chemicals

DESCRIPTION OF FUNCTION AND SUB-FUNCTIONS

Table 10
PROTECTION OF VICTIM (Page 2)

FUNCTION AND SUB-FUNCTIONS	DEFINITION	APPLICATIONS	GENERAL ADVANTAGES	GENERAL DISADVANTAGES	TOOLS AND/OR EQUIPMENT
PROTECTION of VICTIM (Con't)					
Smoke and Fume Protection	Provision of a device to prevent inhalation of toxic smoke and/or fumes	Personnel protection in presence of toxic smoke and/or fumes, during extrication operations	Prevent inhalation of toxic smoke and/or fumes	None identified	Breathing mask with air supply Resuscitator Fans Smoke ejectors

DESCRIPTION OF FUNCTION AND SUB-FUNCTIONS

Table 11
PROTECTION OF RESCUER

FUNCTION AND SUB-FUNCTIONS	DEFINITION	APPLICATIONS	GENERAL ADVANTAGES	GENERAL DISADVANTAGES	TOOLS AND/OR EQUIPMENT
PROTECTION of RESCUER	Any procedure or device which provides a shield or counter-acting agent against a recognized hazard, but primarily those means involving intimate contact or danger to the body of the rescuer within a close proximity	Primarily during GAINING ACCESS and DISENTANGLEMENT, but also during TRANSPORTATION TO AMBULANCE	Protection of rescue personnel against natural and/or induced hazards during performance of extrication operations	None identified	Refer to itemized sub-functions for specific items
Heat Protection, Passive (Insulation)	Insulation by fabric material with reflective characteristics or non-conductive nature	Fire-fighting, gaining access, use of burning torch or other heat producing tools	Personnel protection during extrication operations in which heat-producing tools are used, or vehicle components are hot from extinguished fire	None identified	Proximity suits Goggles Gloves Hard hats
Cold Protection, Passive (Insulation)	Insulation by nonconducting fabric or other material	Body protection during cold weather operations, or during scuba diving activities such as underwater rescue	Personnel protection against chilling or freezing, to permit performance of extrication tasks	None identified	Gloves Clothing or protective garments (various types)
Cold Protection, (Active)	Provision of heating by active chemical or electrical means	Used to warm hands, provide hot liquids (coffee, chocolate) during cold weather rescues	Minimize discomfort to rescue personnel during extrication operations	Time to set up equipment	Stove, gasoline Space heater, electric or gasoline
Electric Shock Protection	Provision of a rubber coating or other dialectric material between electric power source and rescuer	For handling "hot" electric powerlines knocked down by crash or storm, or handling of electrically operated equipment in wet conditions	Personnel protection against electrical shock or possible electrocution	None identified	Gloves, insulated (rubber, leather, etc.) Electrical insulating material on handles of various tools
Missile and Spark Protection	Provision of shielding against flying particles	Primarily required during use of high speed sawing and chipping operations	Personnel protection, primarily for metal cutting operations	Protective device may somewhat restrict field of view	Hard hat Goggles or face mask (shield) Gloves, protective Jacket, protective (leather)
Protection Against Abrasions or Lacerations	Provision of protective clothing to prevent abrasions or lacerations	Primarily for handling wreckage during extrication operations, or working among debris	Personnel protection against abrasions or lacerations when handling jagged metal, broken glass, etc.	None identified	Hard hat Goggles or face mask (shield) Gloves, protective Jacket, protective (leather) Boots
Smoke and Fume Protection	Provision of a device to prevent inhalation of toxic smoke and/or fumes	May be used in case of fire during extrication	Prevent inhalation of toxic smoke and/or fumes	None identified	Mask, smoke or gas Mask, full face

DESCRIPTION OF FUNCTION AND SUB-FUNCTIONS

Table 11
PROTECTION OF RESCUER (Page 2)

FUNCTION AND SUB–FUNCTIONS	DEFINITION	APPLICATIONS	GENERAL ADVANTAGES	GENERAL DISADVANTAGES	TOOLS AND/OR EQUIPMENT
PROTECTION of RESCUER (Con't)					
Protection against Sinking					
a. Water	Provision of flotation capability	Rescue of victims from crashes into bodies of water	Facilitates or provides capability to perform necessary extrication tasks	Time to don or set up equipment	Life jacket Life raft (inflatable) Dinghy (or other small boat)
b. Quicksand, Mud, Swamp or Marsh	Provision for effecting greater load distribution or platform for rescue personnel	Rescue of victims from vehicles in swampy, marshy, muddy or quicksand terrain	Facilitates or provides capability to perform necessary extrication tasks	Time to set up equipment	Ladder, boards, and planks Ropes, cable and winch
Protection against Acids and Corrosive Chemicals	Provision of a shielding device or a counteracting chemical agent to protect against corrosive action of chemicals	Protection against corrosive or toxic spilled chemicals, such as in tanker truck accidents	Personnel protection against corrosive or toxic materials	Time to don or set up equipment	Protective garments Rubber boots Chemical agents Hose and water supply to wash away or dilute corrosive or toxic spilled chemicals

DESCRIPTION OF FUNCTION AND SUB-FUNCTIONS

Table 12
POWER SUPPLY AND TRANSMISSION

FUNCTION AND SUB-FUNCTIONS	DEFINITION	APPLICATIONS	GENERAL ADVANTAGES	GENERAL DISADVANTAGES	TOOLS AND/OR EQUIPMENT
POWER SUPPLY and TRANSMISSION	Provision of portable power source or generation, and auxiliary devices, specifically adapted to furnish energy for the operation of various types of power-driven tools and equipment	To provide source of energy for operation of a variety of power tools and/or auxiliary or support equipment required for performance of several functions throughout the various phases of extrication	Essential for performance of extrication operations utilizing tools or other equipment which require an external power or energy supply (i.e., electrical or pneumatic tools, illumination, etc.); augment human capability	Stowage space required for equipment; set-up time and start-to-power-available time may be lengthy (time tc prepare for use); power supply equipment may require constant maintenance (charging batteries, etc.)	Refer to itemized sub-functions for specific items
Electrical Power	Provide portable AC or DC electrical power by any of several methods (generator, batteries, power take-off, etc.), for use of electrical equipment	To provide electrical power for utilization of various types of support equipment (lights, heaters, etc.). which may be required for a variety of extrication tasks	Essential for performance of extrication operations using electrically powered tools or support equipment Necessary for illumination for night operations or adverse lighting conditions	Electrical support equipment frequently requires relatively large stowage volume in emergency vehicle; additional support equipment may be required; frequent periodic maintenance usually required to maintain state of readiness	Generator, portable (gasoline-powered) Batteries, rechargeable (various types, sizes and capacities) Power take-off from vehicle Carts or stands Extension cords Support equipment (miscellaneous)
Pneumatic Power	Provide portable source of air or compressed gas, by use of compressors or reservoirs, to operate air-driven equipment	To provide air or gas supply for utilization of various types of pneumatic tools which may be required for a variety of extrication tasks (such as jack, hammer, chisels, drills, power wrenches, etc.)	Essential for performance of extrication operations using pneumatic tools. Use of penumatic tools is preferable to electrically operated equipment when a fire hazard exists (i.e., spilled fuel)	Frequently requires relatively large stowage volume in emergency vehicle; additional support equipment may be required	Compressor (usually gasoline-powered, but may be electrical) Reservoir (bottled air supply, portable or tank on emergency vehicle) Carts or stands Hoses (high or low pressure Valving (as required for specific equipment) Support equipment (miscellaneous)
Chemical Power	Provide portable power source, fuel or gas, for operation of chemically-powered equipment	To provide compressed gas or fuel supply for utilization of chemically operated equipment useful in a variety of extrication tasks (such as cutting torch, heating equipment, lanterns, gasoline-powered saws or other tools, etc.)	Essential for performance of extrication operations using chemically-powered devices (tools or support equipment)	Frequently requires relatively large (or specialized) stowage volume in emergency vehicles; special or precautionary handling may be required; hazardous to use this type equipment with fire hazard present (spilled fuel, dry grass or other combustibles, etc.); may be hazardous to trapped victim	Cutting torch, oxy-acetylene Carts or stands Hoses Valving (as required for specific equipment) Fuels (liquid or compressed gas) Internal combustion engines Protective equipment (gloves, goggles or masks, jacket, etc.) Ignition devices Support equipment (miscellaneous)

DESCRIPTION OF FUNCTION AND SUB-FUNCTIONS

Table 12
POWER SUPPLY AND TRANSMISSION (Page 2)

FUNCTION AND SUB-FUNCTIONS	DEFINITION	APPLICATIONS	GENERAL ADVANTAGES	GENERAL DISADVANTAGES	TOOLS AND/OR EQUIPMENT
POWER SUPPLY and TRANSMISSION (Continued)					
Hydraulic Power (Force multiplication and transmission)	Provide closed-loop system with suitable fluid, to serve as a force multiplier and power transmission means for operation of hydraulically operated equipment	To provide means of multiplying and transmitting forces (usually manually applied), in a variety of equipment useful in extrication tasks	Essential for performance of extrication operations using hydraulically operated equipment; considerable forces may be generated with a relatively low input force; versatile method of performing many functions	Hydraulically operated equipment (except hand tools) may be comparatively heavy; reactive surface usually required for operation; frequent periodic maintenance may be required to maintain clean-lines of system and system integrity	Hydraulic jacks Hydraulic rescue kit Hand tools (miscellaneous types are hydraulically operated) Hoses (high or low pressure) Valving (as required for specific equipment) Support equipment (miscellaneous)

Table 13
EXTRICATION FUNCTIONS VS. PHASES

General Functions	Phases of Extrication Process: Reporting and Dispatching	Rendering EMC	Transport to Scene	Traffic Control	Hazard Control	Gaining Access	Disentanglement	Preparation for Removal	Removal (Initial Movement)	Transport to Ambulance
Communication	X	X	X	X	X	X	X	X	X	X
Airway Provision and Resuscitation		X						X	X	X
Control Bleeding, Bandaging and Provision of Miscellaneous First Aid		X						X		
Sampling Blood Measuring		X								
Shock Control		X								X
Comforting		X								
Travel by Vehicle			X							
Illumination		X	X	X	X	X	X	X	X	X
Visual Warning and Signaling			X	X	X					
Fire Suppression and Prevention				X	X	X	X	X		
Protection of Victim		X		X	X	X	X	X	X	X
Protection of Rescuer				X	X	X	X	X		X
Debris Removal			X	X	X	X	X	X		X
Power Supply and Transmission	X	X	X	X	X	X	X	X	X	X
Vehicle and Debris Stabilization					X	X	X	X		
Severing, Rending, and Dividing					X	X	X	X		
Distortion						X	X	X		
Displacement				X	X	X	X	X	X	X
Disassembly					X	X	X	X		
Immobilization of Victim		X					X	X	X	X
Facilitation of Grasp, Guidance and Support						X	X	X	X	X
Miscellaneous Functions	X	X	X	X	X	X	X	X	X	X

is a problem in the standardization of rescue services in that people traveling from one part of the nation to another may not be aware of the proper source of help. They may attempt to call the wrong agency in order to obtain help for an accident on the highway. Therefore, there is some value in the standardization of agency responsibilities throughout the nation, or at least in the standardization of contact points and methods for beginning the process of dispatching. It is probably true that there are economic and statistical bases for selection of various agencies in different parts of the country and regional variations which favor one organizational system over another.

This is a first effort in developing a standard training course on auto extrication. We are certain there are many highly skilled rescue organizations in the U. S. We do not pretend this course of instruction is all conclusive. If you have any criticism of any part of this course please do not keep your objections to yourself. We welcome constructive criticism. If you notify: NHTSA – Rescue & Emergency Medical Services Division, 400 7th Street, S. W., Washington, D. C. 20590, of your suggested changes and/or additions they will be evaluated and if valid included in future revisions, with appropriate credit to the service making the recommendations.

E. REFERENCE

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